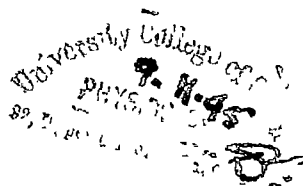


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*"To the solid ground
Of nature trusts the Mind that builds for aye"* —WORDSWORTH



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RESETTLEMENT OF POPULATIONS

IT is inevitable that some of the most pressing problems of the post-war world will centre around the question of redistribution of population, for this is not only at the root of matters of over-population and employment but concerns also the question of the place of minorities outside the national major consciousness in many areas. The problems will arise in Europe, in the tropical colonies, in South America, and in the great Dominions. While it is a mere truism to say that the globe still offers considerable areas of under-populated and scantily productive lands, it is obvious that the problem of shifting populations from one area to another involves far more cogent considerations than a mere study of numbers and population density.

The intricacies of the problem of redistributing populations are great and cannot be settled on a narrowly statistical basis. Following on a mere trickle, mainly of adventurers and unwilling deportees in earlier centuries, the nineteenth century was a period of free and unregulated flow of population from Western Europe to the poorly populated regions of North America, Australia, New Zealand, etc., and to a less extent from Mediterranean Europe to South America. The outward flow was actuated partly by economic failure at home, partly by political unrest, and most of all, perhaps, by the brighter hopes of prosperity born of the growing need of the industrialized lands to increase their food imports.

The need for exotic raw materials as well as the hope of establishing new markets for manufactured goods led also to the establishment of sovereign claims to almost all parts of intertropical Africa and other areas in low latitudes. These areas, unlike the temperate lands, afforded little or no outlet for European settlers but raised many thorny problems in control and utilization. The number of Europeans engaged in directing the native cultivator and urging him by one means or another to increased output is small; but the means of controlling these tropical areas and their local inhabitants has fomented serious problems in the redistribution of population and unfortunate interference with tribal life and native culture, to an extent scarcely compatible with high standards of either equity or wisdom. In Africa, outside the tropics, the white man finds land within the margin of his demand for progressive settlement, but the margin is often a fine one and is liable to be transgressed. Both in North and South Africa, the European has to compete with established races admirably suited to the environment.

Racially, this new dominion of the tropics did not involve the destruction of aboriginal inhabitants—as in most expansions to temperate lands—but rather a desire for increased native population to meet labour demands. The large-scale migration was not merely a European exodus. Later, but in a steady flow, the dense agricultural populations of the East sought more productive homes as Indians moved to East Africa and Malaya, Chinese to Malaya, Burma and Pacific islands, and Japanese to Hawaii and North America.

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Attempts in the nineteenth century and earlier to transfer people from high to low latitudes met with little success, and the failure of the experiments was attributed to unsuitable climatic conditions. There were, however, other factors at work, and even in temperate lands the suitability of the climate was not the sole factor in promoting success or apparent success. The twentieth century saw a checking of the growing outward flow of population from Europe, largely due to legislative decisions of various States which affected even more drastically the coloured races. These restrictions were based mainly on economic grounds, but biological and political expediencies were not overlooked. The danger of lowering the high standard of living by the introduction of cheap coloured labour was no doubt as powerful a motive as the inability of the State to absorb into national unity so many alien racial elements, in closing the doors of North America and the Commonwealth of Australia to other than 'white' races. The lodgement of many Italians in the Argentine, and Swiss and Germans in southern Brazil, was in the first case due to political affinity of the Latin outlooks, and the second to political expediency in the avoidance of unsympathetic majorities in more obviously suitable lands. The danger of Brazil's experiment with Japanese colonists is a glaring example of lack of vision in this respect.

The experience of several countries has at least made clear the complexity of the problem, but the expediency of organized migration was never more pressing than it will be in the near future. If it be left to the dictates of political rivalry untempered by an appreciation of the many issues involved, little or no success can be anticipated. There are many aspects of the problem besides the political one. The physical factors for successful settlement are so obvious that they tend to obscure subtler considerations. Surface relief, soil, water supply, routes and transport facilities are clearly of importance. Ways of living, types of houses, clothing and diet, habits in which people are strongly conservative, are largely bound up with climate, but climatic influences resolve themselves largely into the amount of insolation, a function rather of latitude than of climate, and degree of relative humidity. Then again, many of the failures, formerly attributed to the climatic factor, to colonize or even effectively to dominate intertropical areas have been shown to be due to diseases, especially insect-borne diseases and in measure as the insects can be destroyed or kept at a distance the threat of diseases disappears.

Another and totally different factor arises from the existence or not of the colour bar, coupled with the desire to avoid hybrid races. This feeling differs widely among migrating peoples and is strongest in those with least pigmentation. Another biological factor is of primary importance. There can be no true colonization unless the birth-rate remains high in relation to the death-rate. If the latter increases and the former decreases, the experiment of transferring population is doomed to failure. This important factor is impossible to predict, and seems to vary not only in regard to racial stocks but also in relation

to the actual density of population. Some elements in a population seem to show a lowering of fecundity as density increases. Each land and each race stock have their optimum densities. This optimum density is determined also by economic factors. The standard of living falls in an area where subsistence farming is carried too far, even though it may be temporarily relieved by industrialization. A potent biological consideration is the competition by wide divergent races. The attempts at Japanese expansion which have occurred during the past forty years is the chief example. Virtually all important outlets have been closed to them, and none will probably be open after the defeat of Japan in the present War. Japanese aims, and to a less extent Chinese aims, involve racial rivalry rather than intertribal competition.

There are, of course, many other economic factors involved, such as location in determining proximity to markets, and the relation of aboriginal to introduced labour. While above and beyond these considerations is the political one, which is concerned with avoidance of the national disunity that arises from the growth of small groups of traditions, culture and languages distinct from the majority, and the resultant weakening of national consciousness. Considerations such as these are all of importance in deciding the uprooting and replanting of populations. Varying weight must be given to the different considerations in every case. Within Europe, where the climatic factor may be less important, the economic and cultural ones are of greater weight. An acre for an acre can never denote an equitable exchange, and no measure of even comparative stability can be obtained that does not envisage room for growth of population.

The capacity of the land to bear increased population is of vital importance. Even before an area is fully utilized, impoverishment of value and decrease in productiveness nearly everywhere is a potential and often an actual threat. Somewhat tardily it has been recognized that every productive area has a limit to the demands that can be made on the land and this limit is not merely one of soil fertility, important as that is, but is intimately bound up with rainfall and its fluctuations from year to year. Deserts advance through human folly rather than by change of climate.

There is another side to this large-scale migration and that is the effect on the lands of origin. With the exacting demands of the States receiving emigrants as to good physical and moral stock, there is a drain of the best and an increasing pool of the weaker in the homeland. The wider world, where open to colonists insists that no imperfect stock shall enter. Economically also, the drain, if confined either to agricultural or to industrial population, may have harmful effects on the home country in disturbing the balance between rural and urban life, and checking one or another aspect of production.

In his address as retiring president of the American Association for the Advancement of Science delivered at Ohio on September 11, part of which is printed on page 5 of this issue, Dr. Isaiah Bowman dealt with problems of this nature, and showed that the solution

be found only by the scientific study of environments leading to an understanding of their capacity for population of different degrees of culture and economic development. In practice, most of the areas of settlement of high potential are marginal lands, this intensifies the problem, but makes more insistent a scientific survey of their capacity. Some lands will require considerable capital outlay before they can be regarded as satisfactory homes. The Soviet Union has found that to be true of its subarctic main and has succeeded in implanting a considerable population in lands formerly regarded as useless. This scientific study of environment is peculiarly the province of the geographer, who in correlating the complex functions of the many factors involved can bring realism to the study of phenomena which in separate isolated studies are liable to become abstractions. A mere descriptive study will not suffice, nor will a purely analytic study help. There must be relation between the exact physical factors and the variable human factors before any sure ground on which to base predictions is reached. The problems to be solved in transferring populations are concrete and need the illumination of the scientific outlook, and cannot equitably or with stability be solved on the grounds of mere political expediency. This applies both to the newer marginal lands and to the older populated lands, even if the weight of the various factors varies in different cases.

CONSTRUCTIVE DEMOCRACY

T.V.A. Democracy on the March. By David E. Lilienthal. (Harcourt Special, S 151) Pp. 208+15 plates. (Harcourt, New York: Penguin Books, Ltd., 1944) 9d.

T.V.A.

Lessons for International Application. By Herman Finer (Studies and Reports, Series B: Economic Conditions, No 37) Pp viii+289 (Montreal: International Labour Office, London: P. S. King Staples, Ltd., 1944) 150 dollars, 6s.

THESE two books make an admirable supplement to the account of the Tennessee Valley Authority which Dr Julian Huxley gave us last year. Their value is sufficiently indicated by their sub-titles. In the first, Mr David E. Lilienthal, chairman of the Tennessee Valley Authority, gives us from inside an interpretation of this great experiment in regional planning, as much from the point of view of its significance for the future as from that of narrating technical and social achievements up to the present. It is the more popular of the two books. It is well written and well documented, but endeavours to indicate the spirit rather than the technical details of achievements in the Tennessee Valley. Mr Lilienthal is at pains to make plain the factors which contributed to its success in the face of much vicious opposition and misrepresentation. To the extent to which he has succeeded in this aim, indicated by the place which the book must rightly take in the discussion of the machinery of democratic government. It is a major contribution to debate on the relations between central, regional and local administration which must be faced in

Great Britain if any effective solution is to be found to the problems of reconstruction, town- and country-planning and the location of industry. Mr Lilienthal indicates at once the way in which the dilemma between planning and freedom may be resolved and in which fresh life may be brought into our democratic institutions by giving local interest and initiative more effective scope.

It is thus as a contribution to constructive thinking about planning, the demonstration that the regional planning of resources in conformity with broad national objectives and policies is possible, with full participation, through decentralization, of the people themselves, that the book has its greatest value. Technical achievements are only incidentally described, but Mr Lilienthal has fully recognized that the experiment has involved solving the problem of the use of the technical expert in government, and that it is an experiment in government as well as in the development of national resources. His chapters on "Experts and the People", "Decentralization", "Regional Pillars of Decentralization" and "Modern Tools for a Modern Job" are not only lucid expositions of the way in which T.V.A. functions but also a contribution to the literature of scientific administration.

In his chapter "T.V.A. and World Reconstruction", Mr Lilienthal touches on the other factor which has given the Tennessee Valley Authority its general interest at the present time, and which is the main theme of Dr Herman Finer's book. If this book is less well documented, it is more fully provided with statistical data, and the factual account of the Authority's achievements is more complete. The emphasis on the administrative machinery is similar: there is the same stress on the balance between a national plan, regional development and local co-operation, on the social as well as the technical objectives, and the establishment of the right relations between knowledge and power.

Five of the fourteen chapters of the book are in fact devoted to staff and administrative problems—the corporate agency and its methods of operation, management and personnel, Federal controls and State relationships, the employee relationship policy and labour, and employee welfare services, with which Dr Finer has himself been more particularly concerned. Although much of this is relevant rather to American than to British conditions, and regard should be had to the fact that the United States, generally speaking, is a generation or two behind Great Britain in its labour policies, Dr Finer argues with some reason that T.V.A.'s methods and experience indicate conclusively that public enterprise can attract to, and retain in, its service men and women who will work continuously with devotion and initiative. If they are given work, scientific or administrative, in office, laboratory or field, with a demonstrably high social value; if the work has meaning for them, and if there is security for the continuance of the service and of the livelihood it provides, they may be expected to serve with high, sustained, and increasing efficiency, free from undue envy and acquisitiveness. Nor are Dr. Finer's conditions wholly irrelevant to service in private as well as public enterprise.

The most important chapter in the book, however, is the concluding one, in which Dr Finer discusses the problem of an international T.V.A. His examination of the functions and operation of the T.V.A. was undertaken, first, to record an experience valuable

to those generally interested in the possibilities and conduct of public development works, but more especially to distinguish the problems facing an international agency seeking to assist the development of the resources of under-developed countries. It is in this chapter that Dr. Finer gives us the full measure of his quality, and for this alone the book would be a major contribution to the literature of post-war international reconstruction. It is a sound corrective to whatever extravagance there may be in the expectations raised by the growth of public opinion vaguely favourable to the establishment of such agencies on the precedence of T.V.A.

No such model, Dr. Finer points out, can be regarded as suitable for adoption in every identical feature by other countries. T.V.A. is not transplantable without reservations and qualifications, but its characteristics help to bring out the problems and suggest alternative solutions. T.V.A., as Dr. Finer points out, was the answer to a complex of economic and social problems, which involved the relationship between a nation and one of its regions, poverty-stricken, but with resources capable of development. This lucid analysis clearly indicates the problems involved and the factors of which account has to be taken—the relation between the region and the national or world economy of which it is a part, the necessity of any country seeking international assistance first providing a comprehensive scheme of development, the financial problems, the importance of clear definition of scope of powers, the relation between development schemes and social progress, the importance of training both workers and managers. In his survey of problems of international assistance, Dr. Finer recognizes the room for "wide range of diversity", nor does his caution lead him to strike any the less confidently than Lilienthal or Huxley the note of hope.

The Tennessee Valley Authority has clearly shown the way democracy can march forward. The clear understanding of what is involved in that experiment and of the factors responsible for its success should at least assist in an apprehension in Great Britain of post-war problems of reconstruction and development, national and international, which will increase the prospects of the right measures and solutions being found and implemented. R. BRIGHTMAN

ELLIPSOIDAL WAVES OR RELATIVITY?

Propagation Ellipsoïdale, Relativité, Quanta

Par H. Varcollier. Pp. iii+398 (Alger: Baconnier frères, 1942.) 20s.

"It is the customary fate of new truths," said T. H. Huxley, "to begin as heresies and end as superstitions." In at least one large London college, relativity was for some time regarded as a heresy, or at best a kind of pure mathematics that had drifted out of touch with reality. Now we believe that relativity is the only theory that can explain certain experimental results. This belief is mere superstition unless we are prepared to examine alternative explanations, such as that offered by M. Varcollier.

In an earlier book, "*La Relativité dégagée d'hypothèses métaphysiques*" (1925), he claimed that there were several hypotheses which could explain the Michelson-Morley experiment without abandon-

ing classical ideas of space and time. He has worked out in considerable detail the consequences of one of these hypotheses, namely, that the wave front due to a source moving in a straight line with velocity v is a prolate ellipsoid the centre and wave focus of which are respectively at the instantaneous and simultaneous positions of the source. In other words, the wave front differs from the usual sphere of radius ct in that the diameters perpendicular to the direction of motion are contracted in the ratio $\sqrt{1 - v^2/c^2}$. This makes no appreciable difference to the common phenomena of optics, for both hypotheses give the same velocity in the direction of motion, and normal velocities are in the ratio given above, which for ordinary values of v is hard to distinguish from equality.

Several chapters are devoted to the mathematical development of what we may call the "ellipsoid theory", and many of the results differ only slightly, if at all, from the corresponding results of relativity. In particular, we find a complete analogue to Lorentz transformation. The climax is the 'ellipsoid' explanation of experiments which are usually cited in support of relativity. Although M. Varcollier's theory is not compatible with the relativity postulate of the universal constancy of the velocity of light, it obtains a constant total time for the double journey of a ray such as occurs in the Michelson-Morley experiment. He is equally successful with another negative experiment, that of Trouton and Noble. Coming to the positive experiment of Doppler-Fizeau, with a law for the composition of velocities which, to a high degree of approximation, is the same as that of relativity, M. Varcollier gets an approximately equal result. In the case of Sagnac's experiment, so embarrassing for the whole-hearted believer in the relativity of rotation, in which light travels in opposite directions round the circumference of a rotating disk, M. Varcollier obtains the well-known formula, confirmed by experiment, for the displacement of the interference fringes. This arises naturally from his idea of absolute space; he is scrupulous in pointing out that in this case the 'ellipsoid' hypothesis is not essential, as a spherical wave front would give the same result.

So far the author has done very well, but surprising to find no reference to the eclipse of the advance of the perihelion of Mercury, or spectral shift of light from the sun. Yet it was these three pieces of evidence, or at any rate the two of them, which were chiefly responsible for raising relativity from a heresy to an orthodox tenet.

There is a final chapter (Chapter 9) which is not fair to criticize in detail, as it is avowedly only a sketch of possible extensions of the preceding principles. It contains, among many other things, a theory of the motion of an electric particle, remarks on nuclear magnetism, the proton, neutron, and the Bohr magneton. There is also a quantum mechanics, in which it is emissive of quanta that are quantized, a breach with the accepted theory that is explicitly acknowledged. However, Planck's constant and Sommerfeld's equation appear unchanged, and the fundamental Rydberg-Bohr spectral formula is not much changed.

Whatever may be thought of M. Varcollier's results we can all admire the courage which sustained him in the darkest hour of his country's history, to continue his researches and to complete them for publication in Algiers, far from the facilities of Montpellier in France.

H. T. H. PIAGGI

LAND SETTLEMENT AND RESOURCE DEVELOPMENT*

By DR. ISAIAH BOWMAN

President of the Johns Hopkins University

Choice of Essentials

It may be assumed that well-organized peoples work within the limits of more or less deliberate choices of essentials as modified by the accidental and the unpredictable. To-day the people of the United States insist on a high standard of living as a choice among a number of essentials, because access to the world's wealth, or the power to create it, are now taken for granted, thanks chiefly to geographical discovery, the inventions that have come out of modern physics and chemistry and the changes due to plant introductions and plant breeding. In Britain, the post-war standard of living is at times seemed as important as the War itself, housing now has first priority in post-war plans, civilian supplies second, and manufacture for overseas trade third. It is held that the War will not be won to the returning soldiers if decent places to live in are not assured.

How to marshal our forces in support of the great ease we intend to live by has now become one great essential. Resource development is tributary to that; we cannot lay out the lands and dominions of the world and disinterestedly observe where and how development should proceed to give us a rational scheme. We are not free in this respect. Our fate is now bound to other lands far and near. There is no such thing as 'pulling out' of a world war or the peace that follows it. The fine net of world circumstance tangles us all. This is the political context of land settlement and resource development from now on.

If this reasoning be sound, we must look at marginal lands not as permitting, but rather as compelling, action. Some of the largest tracts are in the British Empire. Canada and Australia have too few people, considering the territory they embrace and strategic value. It is urgent business to fill these under-developed lands. The population structure of the British Isles is such that a decline is forecast to thirty-two millions by 1976 (Carr-Saunders). Half the assumed rate is alarming enough. A general overseas movement from Britain to the distant dominions is therefore out of the question. Where all the non-British migrants be found who will not readily people the Dominions? In Europe certainly, but this clearly means the designation of desirable stocks, encouraged migration and a certain measure of accelerated nationalization. The last-named is necessary for purposes of unity (through education) in essentials of community life, and for the political cohesion that self-protection demands. Migrants are without education in the history and traditions of the country to which they migrate, or the capacity to benefit by them, they may weaken the nation in a period when cohesion and strength are matters of life and death.

If there is agreement on these essentials, we must aid the settler in choosing the best lands for given crops, the best cultivation techniques for quality and

the best market conditions, as well as the limits of production in relation to price levels. The virility and imagination which Mackinder invoked on Britain's behalf in 1902 as he looked at the perilous facts of British geography, demography and power, are now most urgently required by all of us. The insularity of the British Isles is only different in degree from that which marks the present situation of the United States. Our great strength is sustained in part by drawing upon a wide range of foreign products. Any human stock that has staked out its portion of earth as the home of free institutions must now effectively occupy and defend what it claims. Having chosen a course, every support that science, sense and experience can bring should be marshalled to people the best remaining lands with assimilable stocks capable of making a sound choice of essentials.

The word 'assimilable' is important. Political unity is short-lived unless continuously nourished. Land settlement in the post-war period starts with people. Land is secondary. We cannot create a special citizenship bound to the land. Only the serf and the bondsman are so restrained. It is alleged that the only Venezuelan agricultural colony settled by immigrants since the colonial era that has survived to the present time is Colonia Tovar. It is in the coastal Cordillera, twenty-two miles from La Victoria, and was founded by Codazzi a hundred years ago. W. D. Rasmussen concludes that its unique success is a reminder to Venezuela "that it would not be advantageous to have the Nation's unused land settled by isolated frontiersmen on a subsistence level or by nationalistic groups. Social and economic integration are essential."¹

The integrating powers of States differ as much as their physiography and economic life, education, sports, speed and volume of circulation of newspaper and mails, and all the other attributes of culture differing so widely. That is why a world-imposed theoretical plan of settlement would most certainly fail, whereas national programmes inspired by disinterested local studies of a scientific nature may succeed.

Over-all Conditions A Basis of Judgment

If the limits of land settlement are to be drawn strictly on the basis of immediate economic returns, there will be no general venturing. Success demands an immense excitement about settlement, but an excitement controlled by a choice of essentials, the social context, the scientific findings, the deliberate choice of things it is meant to do and pay for, whether they are economic or not. Sound conclusions as to what is or is not economic in pioneering are few in number. Medical science has a good word for the assemblage of over-all conditions upon which a judgment must be based. The word is 'syndrome'. It is defined as 'a group of signs and symptoms that occur together and characterize a disease'. Fever is the accompaniment of many diseases. The same is true of pain. But one diagnoses a given case by the things that occur uniquely together.

This 'occurring together' is characteristic of each type of marginal land. It is worse than useless, it is misleading, to say that the average rainfall of a certain area is sufficient to support good crops four years out of five and therefore it is safe to engage in wheat and barley cultivation or cotton or corn. The interpretation of rainfall in terms of crops is but one

* Portion of the address of the retiring president of the American Association for the Advancement of Science, entitled "Commanding our Wealth", delivered at Ohio on September 11 and published in *Science* of September 15.

factor in an extremely complex set of circumstances

Each crop and each method of cultivation must be studied in relation to each soil type, each vegetation type, each rainfall type, each slope gradient, in combinations that must be analysed fundamentally and not in the light of a particular political thesis. Good objects from one point of view may be achieved at the expense of other equally good objects

"The station holder [of New Zealand] most 'efficient' in the eyes of his neighbors . . . (in that he frees his hill country of weeds) is often the first to be driven off his holding by advanced erosion. Soil losses are widespread and serious and it is evident that remedies successfully employed in the United States can not be used in New Zealand without considerable modification. In individual regions the problem is unique: each region will require its own solution. The immediate and urgent need is for research and experiment. Effective soil conservation implies the kind of use and treatment of land that exactly fits its capabilities and needs"

The example of tsetse fly control illustrates a conflict of purposes and results that can only be resolved by intensified scientific studies. Each of the twenty-one species of fly has different habits and different requirements as regards vegetational habitat. These differences bring each species in contact with different combinations of food animals. Each species also has a range of habitats.

"Hence the subject resembles the song of the 'Ten Little Nigger Boys'. As you find the solution for one type of country, nine types remain, and so on. But we are finding one thing in common for all the tsetse, each requires more than one vegetational type at a time, and the types it requires must be in contact with one another to support it in all seasons and years. We call this 'concurrence of requirements'. *Glossina morsitans*, for instance, needs savanna wooding to rest and breed in, and vleis to search for food in. Continuous uniform savanna wooding will not support it, while ant-heaps with heavy vegetation, near or at the contact of this and the vleis, add much to the suitability of the general vegetational concurrence. This simplifies the problem very greatly. It means that you need eliminate, by planting or otherwise, only one requirement of the tsetse at one season of the year—or (it may even be) of an exceptional year—in order to eliminate the tsetse"

Conflict of purpose is underscored in the final report of the Drought Investigation Commission of the Union of South Africa (1923). The destruction of the natural vegetation increased soil erosion while decreasing the underground water-supply, thus making more difficult the watering of stock. Complaints having been made by farmers that the planting of catchment-areas in South Africa with fast-growing conifers and eucalypts has diminished the dry season water-supply in certain streams, a special committee of the Fourth British Empire Conference in 1935 considered the problem. In view of contrary evidence and the concurrence of a period of diminished rainfall, the complaints were discounted, nonetheless the committee pointed out the desirability of a comprehensive scientific investigation into the effects of tree-planting on local water-supplies. The lack of scientific knowledge through controlled experimentation could only be made up by precautionary advice. Quoting again from "Colonial Forest Administration"

"In the meantime, in order to allay public anxiety it was suggested that where water conservation was a vital matter, fast-growing exotics should not be planted at the actual sources of streams and the eye of springs, where, however, the natural vegetation should be carefully protected. There has never been any question as to the value of the indigenous forest as a means of conserving and regulating the water supply."

The limited application of scientific results from single areas is a truth that drives home the need for intensive studies, area by area. The combination of controls, risks and needs is often unique. The warning is given that

"Because the white farmers on the karroo sediments of the Cape Colony, or on the dolomites of the western Transvaal have been saved by an energetic policy providing bore-hole water with the aid of 'forests windmills', a similar policy will not necessarily be the same for the nomadic Masai or semi-nomadic Sukuma on the metamorphosed schists or granites of Tanganyika Territory. In Tanganyika Territory, as elsewhere, the layman is apt to shout for irrigation schemes without knowledge of their implications. On recently one read in *The Tanganyika Standard* the following statement: 'Vast areas in the Territory are entirely waterless. This can be altered by a series of canals from which irrigation streams could be made.' It all sounds so wonderfully simple and straightforward. Matters with regard to fire cost, salinity and lack of suitable soils become even worse in those parts of the territory where, in the absence of perennial rivers, irrigation of the reserve type would have to be resorted to. One is, therefore, forced to the conclusion that large-scale irrigation schemes should be left severely alone and that in the light of a recent fuller understanding of the complications of climate, soils, hydrography and markets the early optimism of the Germans regarding the possibilities of such schemes can no longer be upheld"

Brazilian and Peruvian Examples

A useful contrast has been drawn by M. L. Cook in "Multiple Purpose Rivers", between the São Francisco River in Brazil and the Amazon, the Amazon being limited by the fact that it is not a 'multiple-purpose' stream. Throughout its course the lowlands there is no opportunity for electric development and no proved coal deposits. By contrast the São Francisco Valley has a good alluvial floor, irrigable acreage "as much as that of cultivated Egypt", and good sites for dams and power plants that would extend water control and power development and provide the manifold services and opportunities that now make the valley "socially inert for lack of a plan".

Social inertia has many facets. Is its source diet, or the extent of the tradition that manual work signifies reduced status? Or is it due to the prevalence of malaria and dysentery? Is a bad transport system contributory? The settlers from Ceará, a region recurrent droughts, plus others from Rio Grande do Norte, Paraíba, Pernambuco and Alagoas, represent a new migration drift through the São Francisco Valley, 160,000 left Bahia for São Paulo between 1936 and 1942, a large number from the valley itself. From the port of Joazeiro the bulk of the migratory tide moves upstream by riverboat. Permanent settlement in the valley, despite the tide of potent

ttlers, is scant and the population density remains low because of the inflexible pastoral pattern and the semi-aridity.

The slightest increase in population is apt to upset the delicate balance between population and resources which has been achieved as a result of the natural ebb and flow of humanity over a period of centuries, "and may easily strain beyond the limits of elasticity the carrying capacity of existing wells or pools, natural or artificial. Not until the vise-like grip of the present extensive economy is broken and the use of the water rationalized, can there be sufficient progress in the valley to make possible an increase in population."

The settlement possibilities of the Amazon have always stirred the imagination of travellers, sometimes for and more often against intensified occupation. Some overlook the profound handicaps of isolated settlements as set forth in a useful medical survey by M. H. Kuczynski Godard⁷, of the selva of the Rio Perené in Perú, with a chapter on Amazonian colonization in general. No report shows more clearly the necessity for writing the terms of settlement of the Amazon Basin and its borders in their social context rather than in terms of the imagined possible. It is immensely costly to give modern medical services to settlements so widely dispersed, and health conditions are in general deplorable. Godard emphasizes the desire of enterprising persons to leave the region for more comfortable and more sanitary places, a negative migration which steadily drains off the best. There results a tendency on the part of white settlers to remain stationary, primitive, morbid, hopeless. This brutal land is a sign of God's power, wrote Justos, in the purple terms of the romantics. If we say that the Indian has adapted himself to it, the answer is given that to master his environment he has spent all his energy and has done nothing more. He exists without change. His religion is magic, and tradition and fear perpetuate it. For the whites, education, medical services, and enterprise through outside aid are prescribed. Government recoils at the expense. It is held that there are safer and more comfortable places for enterprise.

The border of the Amazon basin may one day display a different aspect. That border is an empire in itself. It has the climatic and vegetative diversities of varying altitudes. It has access to the highlands in the west in Bolivia, Perú, Ecuador and Colombia. It is the exception to the gospel of land scarcity in Perú, as set forth recently by R. A. Ferrero⁸. Relaxation from the continued high temperatures and relentless humidity can be found most readily by locating settlements near the upland mountain borders of the basin and at moderate altitudes. Local air conditioning in the lowland plains will give temporary relief, but it is no substitute for a change of scene and climate.

Of social life in the pioneer zones of Brazil, in general, James writes that "the 1938 immigration decree requires that each colony established in the pioneer zones must have at least 30 per cent of people born in Brazil, and not more than 25 per cent may be composed of foreign people of any one nationality." In the rural schools part-time instruction must be given in Portuguese, and Brazilians must direct the schools.

"The possibilities of settlement in the pioneer zones of Brazil cannot be understood or predicted from a study of the physical quality of the land alone. The kind of people who may desire to undertake the

settlement of Brazil's pioneer zones can not at present be identified, nor can we know what political and social ideas or what technical abilities they will bring with them. Beyond a program of mapping, analysis of the physical quality of the land, interpretation of the present patterns of settlement and of past experience on different kinds of land, the prediction of future population capacity involves too many unknown factors to be profitable."

Meanwhile the problem becomes more and more pressing. "Brazilians have become increasingly worried over the doctrine that vacant land is the patrimony of mankind and should not be allowed to remain idle while millions of humans live on a low standard because of lack of sufficient land. . . The millions of acres of absolutely unused lands in Brazil, the failure to develop the rich deposits of iron, manganese and other minerals caused a natural uneasiness, a recognition that weak nations have always been absorbed by strong ones, that as Bismarck once remarked, natural riches in the hands of those who do not know how to develop them, nor care to do so, are a permanent danger to the possessor."¹⁰

Regional Framework of Settlement

The problem of future migration and settlement is complicated by runaway population-growth in a few countries and the demand that other countries make room for the excess no matter at what cost to social and political cohesion and living standards. Here politics, religion and national ambition are joined fatefully. There can be only further trouble in the international field if we assume that the subject is one so delicate in politics and religion that it may not be talked about. It is equally dangerous to follow the course advocated during the past few years and deny the importance of national boundaries, as if one could change them freely to suit the changing demographic conditions of the world and let populations stream out in every direction at will. Such a policy of progressive revision would be an invitation to constant emotional pressures, to ingenious inventions of argument, to the destruction of treaties by violence, to the undoing of every form of international co-operation.

The possibilities of greater concentration of population in the already densely peopled industrial regions has been emphasized during the past twenty-five years. Primary production requires no forced expansion of settled areas, so long as technology supplies new avenues for investment and employment and corresponding concentration to suit the expanding tastes and diversified needs that technology has already stimulated. As new industries make new demands upon primary production in overseas lands, especially in tropical areas, both the income standards and the demand for manufactured goods will be raised.

"The unemployed in European industrial areas would then find employment at home in producing the things exported to tropical countries. . . The need for emigration decreases with the opening up of such opportunities at home, and as this process is both theoretically in accord with the tertiary stage of industrial development, and has already been occurring on a large scale in practice, we must infer that centripetal movements of population are likely to be more important than centrifugal in future. In a reasonable world the European is likely to benefit most by the elaboration of his skill in his own land.

Given a relaxation of economic barriers, 'Europe is perhaps of all parts of the world the best suited to support a larger population.' If this dictum seems surprising it is only because we have fallen into the error of confusing high density of population with population pressure"¹¹

The theory has been advanced and merits close examination "that differences in density were not causes but rather results of migration, that the basic cause of migration lay in differences in standards of living not necessarily correlated with density of population." An Italian example illustrates the point. The greatest increase in the rate of emigration during 1876-1925, concludes Forsyth, was in sparsely peopled agricultural districts, "a fact showing 'the falsity of the prevalent opinion that there is a direct relation between emigration and density', in fact no such relation appears and in many cases the reverse relation is found."

The mounting scale of home investment in all countries is emphasized by many analysts, likewise the requirement, in overseas agricultural settlement on any large scale, of very great capital sums. "If a country complaining of surplus population could find these sums, it would do much better to consider first whether the money could not be better used at home in stimulating industry so as to furnish employment and raise domestic standards, permitting meanwhile such emigration as could take place without public assistance"¹²

Migration and Boundary Stability

To change national boundaries capriciously would be the highest folly, in my opinion. We cannot undo two hundred years of history by light-hearted talk about the rearrangement of the populations of the world, as if densities could or should be smoothed out. To attempt to do this would at once bring into fatal conjunction differences in food habits, in standards of family life, in that virility and choice of essentials that are required successfully to defend one's own against robbery by war, and in all the other things that we label culture or purpose or ideals. Populations are not mere aggregates of numbers densely peopling the earth here and lightly peopling it there. We must look at the moving spirit of each aggregate. If purposes and ideals disappear, then we are mere livestock and our fate does not matter. It is the ideal toward which we strive that gives our national life a purpose. All these things confront us when we think responsibly about changes in national boundaries. We cannot overlook the importance of property lines, legal administration, taxation and all the other attributes, powers and responsibilities that go with political and purposeful control of specified territories. The nations will certainly not mingle land titles and effects, any more than they will mingle codes and culture systems, or water them down to some common scheme that means nothing to anybody.

To be specific, free migration and elimination of boundary restraints would not solve any identifiable problem of distributing the annual increment of five millions of Indians in other countries. It would only weaken, confuse and distress the rest of the world. Whatever outside responsibility there may be, the Indians also must do something at home about that increment. As for outside responsibility, consider the shipping required to transport overseas five millions, or even one million a year. Consider the social services required to establish them in new places. Con-

sider the communities that they would form of unlike peoples with ideals, historic backgrounds, culture systems, family life, religion, etc., so unlike their neighbours in their new environment. Further, there would be neighbours almost everywhere. A million-Indians cannot be dumped into the Amazon basin in a given year or in five years, for the supply of social services is at a minimum there and adequate services cannot be improvised. They require time for seasoning through experimentation. Power, humanely exercised, has the responsibility of saying how it would absorb what that number of settlers would produce from a forested and savanna terrain. Brazil has the responsibility of saying whether she desires an Indian empire in the Amazon, were one possible of creation. Whether we assume its divisive political influence or its economic and social failure, the problem would be on Brazil's shoulders if she ever attempted so bizarre a social enterprise as wholesale settlement of immigrant Indians in Amazonia. Social and political cohesion worries Brazilian leaders now; they are not likely to invite an enlargement of the area of difficulty.

The nature of some of the problems that arise when two cultures are placed side by side may be inferred from the experience of Fiji. In 1940 nearly half the population was Indian (98,000 out of 220,000).

"Indians have picked out many pieces of good land near native villages and leased them, and the improvident Fijian has been compelled to carry on his agricultural methods on poorer land farther away from his native community. The 'use' of land in the mind of a native is not confined to his need for an area large enough for growing foodstuffs. He desires to retain freedom to search for wild food, for materials for building houses, and to hunt for wild pigs. Young Indians assert 'There are thousands of acres in Fiji not being used. We are British subjects and we want some. We were born and reared here'." The question of landownership and land use is not only important to those who own the lands but is also of vital importance to the Indians who have made their homes in Fiji. Bound up with it is the future welfare of the colony. Native chiefs passed a resolution in 1936, asking, in effect, that the government should control for them all the lands they did not require"¹³

We have already noted inequalities of population density, opportunities, standards of living and political ideals that are bound up with questions of migration and settlement. Behind these inequalities is a conflict of philosophies. In the world of the future a balance of ideas as well as a balance of power may have to be reckoned with. Some students believe that industrialization will start, or at least accelerate, the desired cycle of conditions that lead to reduced birth-rates. Others contend that this will endanger the world's peace by placing greater power in the hands of politically immature peoples.

In a broken world, migration on a large scale is not politically feasible. Employment is an intense preoccupation for the city-half of our population. The War has taught us the crucial need for international unity. The risk of turbulence implied by the whole sale shifting of populations is shunned by every country. The occupation of the remaining lands, a highly desirable end, thus becomes an outward growth from established bases, with science and government sharing the task, the factors of time and personal initiative being taken into account.

Scale as a Factor

The sense of enterprise which permeates successful settlement endeavour depends nowadays upon well-selected sites and a certain scale. Population centres of 3,000-5,000 are required, as well as smaller centres and individual farms, if the varied services that make new homes acceptable are to be supplied. To develop smaller towns or isolated villages of a few hundred, or to go back to lone pioneering, is to call for too great a change in the way of life of present-day settlers. The larger size will also have a conspicuous effect in drawing population from nearby well-settled areas where there may be less opportunity for land development. It is the extension of settlement from already established localities that provides the bulk of the population of pioneer groups. The Inter-Departmental Committee on Migration Policy, reporting in 1934, has a significant statement on the matter from the particular point of view of British overseas settlement:

"We find it very difficult to believe that organized group settlement could deal with, at the most, more than 2,500 families—say, 10,000 souls—in a year, neither the localities, nor the capital, nor the administrative capacity for anything in excess of this—or perhaps for anything as large as this—are available. There are, however, no limits, other than the absorptive capacity of the Empire overseas, to the magnitude of the stream of migration which may be produced by the other method. [The prospective settler migrating with his family on his own initiative or that of a friend or relative.] It was by this method that, in the ten years immediately preceding the war, over 148,000 migrants annually left the United Kingdom and settled in the overseas parts of the Empire. In the ten years 1919-1928, the annual average migration produced by this method was over 132,000. We are convinced that it will be by this method, individualistic, and therefore congenial to our national bent, that the great bulk of migration from this country will always take place."

The extremely important point is made that schemes for settling thousands of families overseas in new communities tend to impress the public by the magnitude of the organization involved, the sums expended and the new names of towns on the map. The bustle and publicity of ship chartering, port building, road construction, co-operative buying and selling and the selection of a balanced population containing the right number of farmers, tradesmen, professional men—all these activities create a stir and excitement that are alleged to have no corresponding practical results when it comes to the real business of counting new settlers and appraising their staying power on the land. But it would be more correct to say that the excitement is out of proportion to the results, thus recognizing the possible value of excitement.

The two methods are not mutually exclusive. The bulk of the lands available for settlement, out of a world total of perhaps three million square miles, can be occupied by self-initiating settlers. There are some areas, however, that require substantial capital investments if success is to be attained. Government will be called on to take the risk of supplying such capital if the objectives include national security or other non-economic ends. We all remember the wide and sustained public interest in the irrigation projects of the U.S. Reclamation Service following the turn of the century. "Homes for Millions" became

a popular slogan. Yet when the twenty-four national irrigation projects had reached the point of substantial development in 1926, there was a total farm population upon them of only 137,000. By contrast, in the two decades preceding, motivated by individual enterprise, there were more than 600,000 final entries under the Homestead Act, in addition to coal-land and desert-land entries.

What the Reclamation Service did was important and desirable. It undertook the large capital-venturing beyond the means of the individual farmer or the small group. Were such capital-venturing to be undertaken for petroleum exploration in Alaska, for example, in parallel with advanced agricultural experimentation, it is possible that the struggling settlements of the pioneer fringe of Alaska would take on a new lease of life and that the enlarged scale of operations would create the excitements and sustain the hopes that are necessary for permanent occupation. But in the end it would be the push, virility and enterprise of individuals that would constitute the final test of staying power and attachment.

Contrasts in National Inventories

The contrast between east and west, about migration and land, in part grows out of our different purposes in using it. Land in China is for subsistence, land is food. In the United States land is one factor in the complicated problem of (1) keeping up a standard of living on the land so as not to sink farmers to the level of peasants, (2) balancing the benefits of total production, city and country, through the intricate mechanisms of an industrial society.

We do not bring all our land into full production because we already have a surplus production. (I will not venture into the tangled question as to whether or not this is only a commercial and not a social surplus.) By contrast, land division in India and China has been carried so far, under growing population pressures, that tens of millions are at starvation-level. The problem facing Governments is how to ease these conditions before Australia becomes an adjunct of India or China. Economic easement in China seems a far more rational solution than merely keeping Chinese out of Australia. If white settlement in Australia is urgent, it is equally urgent to begin the industrialization of China. The balance of ideas and opportunity may thus become a sufficient substitute for the balance of power.

There seems to be a high correlation between prosperity in new lands and migration to them. Historically, that prosperity has been in turn dependent upon the power of industrial centres to buy the raw materials of the producers of the newer lands. If the post-war world enters an era of expansion (to supply the losses of war and delayed consumption demands), there seems to be a clear possibility that the former relation of industrial areas to raw material areas may be substantially regained. The act of industrialization of former raw materials areas in itself will augment the relative prosperity of the latter. There is no reason, therefore, why further settlement and industrialization may not go hand in hand.

Goals of National Policy

As a general working principle, the acceptance of a bare subsistence standard for planned pioneer settlement may be condemned as a national policy, whether in Australia or Brazil. But settlers on their own initiative will also be looking for small doors of

SCIENTIFIC CENTENARIES IN 1945

By ENG.-CAPT. EDGAR C. SMITH, O.B.E., R.N

limited opportunity, not necessarily a gateway to the best the world affords. This may prove true of refugee settlement in particular. For refugees, a higher degree of tolerance of hard conditions has been assumed. Will it work out that way?

A scientific inquiry in each major area proposed for settlement cannot stop short of the goal of acceptable livings. Granted that there must be wide tolerance at first on the part of almost all settlers, can an inventory of resources, area by area, assure them diversified production and enlargement of opportunity with enduringly brief delay? Since most areas of potential settlement are marginal, can scientific inquiry reduce the risks? One may be sure that vast sums will not be spent in the post-war years upon doles to settlers who are badly located. There is every reason, however, why initial aid should be given to well-placed units who will add to the resources and taxable wealth of the countries of their adoption.

The abundance of unused land strikes every observer, yet it is the scarcity of commercially valuable unused land that intensifies the problem. The scientific study of settlement has become to a large degree a study of unused land. What keeps it out of production? Is the soil deficient? Is the water supply undependable? Are the required cultivation techniques peculiar? What is the natural unbalance that must be corrected by scientific study and treatment? The tsetse fly, natural versus artificial vegetation, extreme price changes and soil erosion are among the examples we have mentioned.

No less important is a study in national psychologies. What is the attitude, country by country, toward the foreigner? What part in the shaping or retention of a recognized national attitude is played by experience with groups already established? Are the examples of Colonia Tovar, Cyrenaica and São Francisco correctly interpreted? What is the peculiar nature of the essential political processes in each country? How do the variant political processes play upon or determine migration policies? What are the specific economic equivalents of migration in industry and trade?

When the answers to these and other questions are given, not in the terms of a single specialty, but in the terms of a social and political mosaic, country by country, the science of settlement will have reached maturity. Sophistication of the investigator plays a part in finding practical answers. He must have that "nice tact of circumstances" which enables him to determine reasonably well what specific groups of men can do, or will do, or may be persuaded to do.

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A REVIEW of the scientific centenariés which will occur in 1945 may well begin with a quotation from the autobiographical notes of the English mathematician John Wallis (1616-1703), written when he was eighty. "About the year 1645," he wrote, "while I lived in London . . . I had the opportunity of being acquainted with divers worthy persons, inquisitive into natural philosophy, and other parts of human learning, and particularly of what hath been called the *New Philosophy*, or *Experimental Philosophy*. We did by agreements, divers of us, meet weekly in London on a certain day, to treat and discourse of such affairs. These meetings we held sometimes at Dr. Goddard's lodgings in Wood Street . . . on occasion of his keeping an operator in his house for grinding lenses for telescopes and microscopes, sometimes at a convenient place in *Cheapside*, and sometimes at *Gresham College*, or some place near adjoining.

"Our business was (precluding matters of theology and state-affairs) to discourse and consider of *Philosophical Enquiries*, and such as related thereunto as *Physick*, *Anatomy*, *Geometry*, *Astronomy*, *Navigation*, *Statics*, *Magnetics*, *Chymicks*, *Mechanicks*, and natural *Experiments*, with the state of those studies, as then cultivated at home and abroad."

From those gatherings and others at Oxford sprang the Royal Society, the first official record of which is a memorandum relating to a meeting on Nov. 28, 1660, held in Gresham College. "W. G." wrote

"At Gresham College a learned knot
Unparallel'd designs have lay'd
To make themselves a corporation
And know all things by demonstration."

Of the various subjects Wallis named, "Chymicks" was one which perhaps most needed the experimentalist to remove it from the realm of mystery. Jean Rey, a Frenchman, appears to have been such a man. He was born in what is now the Department of Dordogne, he studied medicine, corresponded with learned men and worked at practical chemistry. His death took place three hundred years ago, but in 1630, fifteen years before he died, he published "Essays de Jean Rey sur la Recherche de la cause pour laquelle l'Estain et le Plomb augmentent de poids quand on les calcine", which was thought worthy of republishing in 1908 and was reviewed in *Nature* of July 9, 1908. This memoir appears to anticipate the discoveries and views of Lavoisier by nearly a century and a half, but A. N. Meldrum (*Nature*, July 30, 1908) states that there is little evidence that Rey made experiments of any value in support of his views.

The year in which Rey died, his countryman Nicolas Lémery (1645-1715) was born at Rouen. He lectured in Paris, spent some time in England as a Protestant refugee, but having embraced Catholicism, returned to France and was given a seat in the Royal Academy of Sciences. To-day he is remembered for his "Cours de chimie" (1675), which went through many editions and was translated into several languages. "The fine imaginations of other philosophers", he wrote, "concerning their physical principles may elevate the spirit by their grand ideas.

but they prove nothing demonstratively. And, as chemistry is a science of observation, it can only be based on what is palpable and demonstrative." The year 1645 has sometimes been given as the birth year of the English chemist John Mayow, but as Dr Douglas McKim has shown, he was baptised in Morval Church, Cornwall, on December 21, 1641.

Passing to 1745, we have the births of Gahn, the Swedish chemist, of Etienne Montgolfier, the younger of the two pioneers of ballooning, of Schroter, whom Miss Clerke referred to as "the Herschel of Germany", and of the much more famous Volta. Johan Gottlieb Gahn was a student under Bergmann, a contemporary of Scheele and an associate of Berzelius. He was a chemist before he was a mineralogist, and a mineralogist before he became a metallurgist. Expert with the blowpipe, he was the first to isolate manganese. Montgolfier, too, was a chemist, as well as being a papermaker, and it was reading Priestley's memoirs which gave him some of his ideas. The monument erected at Annonay in 1883 honours both brothers, and was erected to commemorate the centenary of their first full-scale experiment with a 'machine aerostatique'.

Johann Hieronymus Schroter (1745-1816) was a worthy representative of that great band of amateurs who have furthered the cause of astronomy. Born at Erfurt, he became a law student at Gottingen and knew Herschel's musical family at Hanover. When thirty-three he was made magistrate at Lilienthal near Bremen, and there in his spare time studied the moon and planets. It was Schroter's assistant, K. L. Harding (1775-1834), who discovered the minor planet Juno, and when Harding went to Gottingen his place was taken by the young supercargo, Friedrich Wilhelm Bessel. Early in 1813, Bremen was occupied by the French, and in April Schroter saw his observatory pillaged and his books and writings burnt. He died three years later, a broken man. Though Volta, too, lived through the whole of the Napoleonic Wars, he suffered no such catastrophe. He was born at Como on February 18, 1745, and there he died in 1827. In 1899 and again in 1927, great international gatherings of scientific men were held at Como to mark the centenary of his most important discovery and the centenary of his death. Among Great Britain's representatives at the second meeting were Sir J. J. Thomson, Lord Rutherford and Sir Arthur Eddington.

Of the men of science who died a hundred years ago, few were better known than John Frederick Daniell, who expired suddenly on March 13, at a Council meeting of the Royal Society, of which he was at the time the foreign secretary. London born and bred, and educated privately, his devotion to science led to his admission to the Royal Society at the age of twenty-three. He worked with W. T. Brande, and on the establishment of King's College, London, was appointed to the chair of chemistry. The invention of the Daniell cell brought him the Copley Medal of the Royal Society. While Daniell was busy with his electrical experiments, the retired French watchmaker Jean Charles Athanase Peltier was engaged in much the same pursuits, discovering in 1834 the Peltier effect, the reverse of that made known thirteen years earlier by Seebeck. Peltier was born in 1785 and died on October 27, 1845. Nine days before this, the last of the Italian-French family of astronomers, Jacques Dominique Cassini, died at the age of ninety-seven. His father, Cesar François,

had died in 1784 when seventy, his grandfather Jacques in 1756 when seventy-nine and his great-grandfather Jean Dominique in 1712 at the age of eighty-seven. For a hundred and twenty years a Cassini had been connected with the Paris Observatory, and the record was broken only by the upheaval of the French Revolution. The second and third Cassinis were especially active in geodesy, the great map of France being largely their work. After his dismissal from the Observatory in 1793 by the National Convention, Jacques Dominique, Comte de Cassini, retired to his estate and abandoned astronomy entirely.

Astronomers born in 1845 include Sir William Henry Mahoney Christie (died 1922), Astronomer-Royal from 1881 until 1910, Sir George Howard Darwin (died 1912), Plumian professor of astronomy and experimental philosophy at Cambridge from 1883 until 1912, Arthur Cowper Ranyard (died 1894), a founder of the London Mathematical Society and secretary of the Royal Astronomical Society, through whose efforts the tablet to Jeremiah Horrocks in Westminster Abbey was erected, and the distinguished director of the Paris Observatory, François Felix Tisserand (died 1896). The monument erected at Nuits-Saint-Georges to Tisserand was described and illustrated in *Nature* of November 23, 1899. His "Traite de Mécanique Celeste", it has been said, furnishes a faithful and complete résumé of the state of that department of astronomy at the end of the nineteenth century. In the United States, the year 1845 saw the completion of the Cincinnati Observatory, the first of any size in that country. Its erection was due to Ormsby MacKnight Mitchel, the author of "The Orbs of Heaven", a book which greatly influenced Sir Robert Ball when a boy.

Other workers in the exact sciences born in 1845 were William Kingdom Clifford, Gabriel Lippmann and Wilhelm Conrad von Rontgen. In the days of Huxley, Tyndall, Herbert Spencer and Leslie Stephen, there was no more notable figure in intellectual circles than Clifford, who died at the early age of thirty-four after occupying for eight years the chair of applied mathematics in University College, London. "He was admitted on all hands", said the *Athenæum*, "to be the most remarkable mathematician of his generation, and promised to be a second Cayley." Gabriel Lippmann, For Mem R S, who died aboard the *La France* on July 13, 1921, when on his way home from Canada, was born in the Grand Duchy of Luxemburg, but practically all his life was spent in Paris. In 1886 he became director of the Physical Research Laboratory at the Sorbonne, in 1908 was awarded the Nobel Prize for Physics and in 1912 was elected president of the Paris Academy of Sciences. His process of colour photography was announced in 1891.

Clifford's name is known to relatively very few general readers to-day, Lippmann's to a more numerous but select circle, but the name of Rontgen is known everywhere. While March 27 will mark the centenary of his birth at Lennep, a few miles to the west of Dusseldorf, November 8 will be the fiftieth anniversary of his discovery at Wurzburg of Rontgen rays, or as he called them, 'X-rays'. "Nov. 8, 1895", said Silvanus Thompson, "will ever be memorable in the history of science. On that day a light, which so far as human observation goes, never was on land or sea, was observed." The discovery was given to the world in Rontgen's paper, "Über eine neue Art von Strahlen", read to the

Physical-Medical Society of Wurzburg in December. There was universal recognition of the significance of the step made, and a translation of the paper was published in *Nature* of January 23, 1896. In 1897 the Röntgen Society was founded, but has since (1927) been amalgamated with the British Institute of Radiology. Though born in the Ruhr, Röntgen was educated in Holland and Switzerland. His appointments took him to Wurzburg, Strasbourg, Hohenheim and Giessen, then back to Wurzburg and finally to Munich, where he died on February 10, 1923.

Passing from the realms of the pure sciences to those of engineering, the year 1845 saw the birth of the versatile inventor and investigator Beauchamp Tower (1845-1905), who will long be remembered for his researches on lubrication carried out for the Institution of Mechanical Engineers. Carl Gustav Patrik de Laval (1845-1913), the Swedish pioneer of the steam turbine, Friedrich von Hefner-Alteneck (1845-1904), the German electrical engineer, and the Swiss hydraulic engineer Theodore Turrettini (1845-1916), were all equally versatile and inventive. With Lord Kelvin, Mascart, Unwin, Sellers and George Forbes, Turrettini was one of the Commission appointed in 1891 to deal with the problem of harnessing Niagara Falls. Karl Benz (1845-1929), the German pioneer of the motor-car, had few of the advantages enjoyed by the foregoing, but he left his mark on a growing industry. He began life as a workman in a Karlsruhe machine-shop, but at the age of twenty-six started on his own at Mannheim. There he produced, in 1885, one of the first vehicles driven by an internal combustion engine. In an entirely different field, we have the names of three eminent British naval architects, Sir William White (1845-1913), Dr Francis Elgar (1845-1909) and William John (1845-90). All three were shipwright apprentices in the Royal Dockyards, and all three entered the famous Royal School of Naval Architecture and Marine Engineering at South Kensington, in 1864, the year it was opened. For a time their careers ran on parallel lines, but afterwards diverged, John becoming the manager of the Shipbuilding Yard at Barrow, now a part of Messrs Vickers-Armstrongs, Elgar being nominated the first professor of naval architecture in the University of Glasgow, while White was for nearly twenty years director of naval construction at the Admiralty. By their labours Great Britain was repaid a thousand-fold what the Admiralty had spent on their education.

There was plenty of scientific activity in 1845, though not on the scale of to-day. For its fifteenth meeting the British Association made its second visit to Cambridge. Sir John Herschel was president, and one of the papers was by Joule, who described his paddle-wheel experiments for determining the relation between heat and work. After the gathering, Herschel wrote to Mrs Somerville in Rome: "We had a full and very satisfactory meeting at Cambridge of the British Association with a full attendance of continental magnetists and meteorologists, and within these few days I have learned that our Government meant to grant all our requests and continue the magnetic and meteorological observations." One of the foreigners present was Von Buch, whom all the leading men of science had met at Dr Fitton's in London. "At Murchison's request", wrote A. C. Ramsay, "I took Von Buch to Cambridge on the outside of the mail coach from the head of the Haymarket. His luggage consisted only of a small baize

bag, which held a clean shirt and clean silk stockings. He wore knee-breeches and shoes." Airy, of course, was at Cambridge and in the Senate House lectured on terrestrial magnetism, keeping his audience, as one writer said, "quite enchanted for above two hours". Airy was given to long lectures, and on one occasion at the Royal Institution, his chairman, the Prince Consort, went to sleep. He was indefatigable. As if the directing of the astronomical, magnetical and meteorological work at Greenwich was insufficient occupation, in 1845 he served on the Railway Gauge Commission and a Harbour Commission, planned saw-mills for a dockyard, descended Cornish mines, nearly fainting at the bottom of one, and ascending another by Loam's man engine, "the finest operation that I ever saw", from France sent John Murray an account of the Cherbourg breakwater for Murray's "Handbook" and later in the year dined at York with George Hudson, the 'railway king'.

Early in 1845 at Cambridge, a young man of twenty-one was second wrangler and first Smith's prizeman, one examiner remarking to another, "You and I are about fit to mend his pens". From the University the future Lord Kelvin went to Paris, worked in Regnault's laboratory, and through reading a paper of Clapeyron's learnt about Sadi Carnot's essay, but it took him three years to obtain a copy. Another Cambridge wrangler, Adams, of somewhat more mature age, twenty-six, the son of a Cornish farmer, in 1845 was devoting all his time to his self-imposed task of trying to discover if the behaviour of Uranus could be explained by the presence of a planet no one had ever seen. A young French astronomer, Leverrier, was doing the same thing. Both arrived at the same conclusion, and next year a German astronomer found the planet. A very unscientific controversy arose in scientific circles but to-day the world honours Adams and Leverrier alike.

The Royal Society in 1845 was in the midst of the long presidency of Spencer Joshua Alwyne Compton, second Marquis of Northampton, who following Davy's practice provided the fellows with tea. Samuel Hunter Christie, father of Sir William, was the secretary, John William Lubbock was treasurer and after Daniell's death, Colonel Sabine was foreign secretary. The Copley Medal in 1845 was awarded to the Belgian naturalist Theodor Schwann, the Royal Medals to Airy and to the apparently forgotten Thomas Snow Beck, who had investigated the nerves of the uterus. At the Royal Institution Faraday was pursuing his patient investigations, and in his diary under September 13, 1845, noted his success with glass and magnets, writing "BUT where contrary magnetic poles were on the same side there was an effect produced on the polarised ray, and thus magnetic force and light were proved to have relation to each other".

As to the other scientific bodies, the Chemical Society, then in its fourth year, was presided over by Thomas Graham, the Royal Astronomical Society by Airy, who presented its Gold Medal to that very scientific naval officer Admiral William Henry Smyth while the Geological Society elected as its president the "mild unpretending, differential" Leonard Horner. Geology was still a thorn in the flesh to the strictly orthodox, and on August 3, 1845, Mrs Somerville wrote to her son "The papers (I mean *The Times*) are full of abuse of Mr Sedgwick and Dr Buckland, but their adversaries write such nonsense that it

matters little" On April 1 the Geological Survey had been finally taken away from the Master-General and Board of Ordnance and placed "under the direction and supervision of the First Commissioner of Her Majesty's Woods, Forests, Land Revenues, Works and Buildings" The most important geological book of the year was the fine volume by Murchison and his associates, "The Geology of Russia in Europe and the Ural Mountains", dedicated to the Czar and containing coloured gold pinpointed maps showing the mineral deposits from the northern extremity of the Urals to the Donetz Basin

Experimental science still languished at Oxford and Cambridge, and in spite of the work of Graham at University College and of Daniell at King's College, London was sadly in need of chemical laboratories Largely through the Prince Consort, this need was met in 1845 by the opening in Oxford Street of the Royal College of Chemistry, where twenty-six students gathered to sit at the feet of a young *privat-docent* from Bonn, August Wilhelm Hofmann In those far-off days, there was no talk of "blood and iron", "mailed fists" or "racial superiority", and there was free and friendly intercourse between German and British men of science, to the great advantage of both Hofmann remained in London until 1864, but he came back later, his last appearance being in 1884, when he presided over the dinner given in honour of one of his most famous pupils, William Henry Perkin

By 1845 the peace had lasted thirty years and there was money to spend on all sorts of projects The railway mania had set in, and Robert Stephenson was returning big cheques sent to him more or less as bribes Some half a dozen railway lines, including those between Bristol and Gloucester, London and Cambridge and Manchester and Sheffield, were opened during the year, and as the railways spread so did the electric telegraphs For a shilling, visitors to Paddington or Slough could see "this interesting and most extraordinary Apparatus by which upwards of 50 SIGNALS can be transmitted to a Distance of 280,000 miles in ONE MINUTE" The best advertisement, however, was the announcement of the arrest at Paddington through the use of the telegraph of the Slough murderer John Tawell For the first time, too, a newspaper published a report of a meeting transmitted by electricity Two years before, Colt, of revolver fame, had laid a submarine cable in New York harbour, and in Britain the Bretts were dreaming of a cable between England and France Sea transport was undergoing a revolution Steam vessels were found everywhere, iron ship-building was becoming an industry, and the trials of H.M.S. *Rattler* in 1845 showed the pioneers that screw propulsion was possible for even the stately three-decker line-of-battleship By the spring, the famous iron screw steamer *Great Britain*, once called the *Mammoth*, was nearing completion, and on April 23, 1845, *The Times* said "Yesterday Her Majesty and Prince Albert paid their contemplated visit to this extraordinary vessel" Brunel had the honour of explaining everything to the Royal party, and Francis Pettit Smith, otherwise "Screw" Smith, presented "a very beautiful model in gold, in an appropriate case, of the propeller he had recently fitted to Her Majesty's new tender yacht *Fairy*" The *Great Britain* sailed on her maiden voyage on July 26, 1845, and so opened another chapter in trans-Atlantic travel

OBITUARIES

Sir John Fox, C.B., O.B.E., F.R.S

JOHN JACOB FOX, eldest son of Mark and Hannah Fox was born in London on April 12, 1874, and died on November 28, 1944 He received his scientific education at the Royal College of Science, South Kensington, and at Queen Mary College, London, taking the B.Sc. degree by research in 1908 and the D.Sc. degree two years later He was elected a fellow of the Royal Institute of Chemistry in 1916 He entered the Government service in 1896 and was appointed to the permanent staff of the Government Laboratory in 1904 He became superintending chemist in 1920, deputy Government chemist in 1929 and Government chemist in 1936

During his official career, Fox was called upon to undertake work concerning a number of problems of interest not only to Government departments but also to the general public Among these the following may be mentioned the possibility of substituting for white lead either less-soluble compounds of lead or 'leadless' glaze, the causes of the decay of buildings, the pollution of rivers by drainage from tarred roads, the cleaning and restoration of wall paintings His encyclopedic knowledge of organic chemistry and his sound judgment were called into play in organizing the sections of the Laboratory set up to advise the Board of Customs and Excise in the administration of the Safeguarding of Industries Act and of the duties on silk and artificial silk and on hydrocarbon oils As Government chemist he was chairman of the Road Tar Research Committee and of the Committee on Physico-chemical Problems of the Building Research Board In 1939 he threw himself with great energy into scientific matters connected with the prosecution of the War This aspect of the work of his last years cannot yet be described in detail, but it can be stated that he served on numerous departmental committees and was a member of the Hydrocarbon Oil Duties Committee at the time of his death

Fox found time to undertake a great deal of research In his early years his mind turned to organic chemistry, and in this period he published researches in the acridine series and on the derivatives of 8-hydroxyquinoline and was joint author of the discovery of a new aromatic hydrocarbon diphenylene Later he was interested in spectroscopy and its relation to molecular structure The ultra-violet absorption spectra of alkaloids, sulphur, the halogens and light elements was studied His work on the infra-red absorption spectra of diamond and of some carbon compounds, carried out in collaboration with colleagues in the Government Laboratory, led to the recognition of two types of diamond and to the elucidation of some difficult problems in analytical chemistry Difficulties arising in his official work suggested researches on the solubility of lead sulphate in ammonium, potassium and sodium acetates, on mannito-boric acid and on the composition of some medieval waxes He also published researches on new and improved methods of analysis

Fox had a very alert mind, a photographic memory and abundant energy In addition to the numerous research institutions to which he was appointed in his official capacity, he gave his time freely to the work of scientific societies He was a past president of the Royal Institute of Chemistry, of the Oil and Colour Chemists' Association and a vice-president of

the Society of Chemical Industry. He served on the Council of the Chemical Society and was a manager of the Royal Institution. He always had at heart the welfare of Queen Mary College, its students and its old students. He was one of a small band of distinguished old students who met together several times a year to keep track of old members of the College and to give them a helping hand when necessary. He was made a fellow of Queen Mary College in 1937.

Fox was always willing to help. He never allowed red-tape to interfere with his official contacts with industry. He gladly saw the representatives of chemical manufacturers and other traders, and freely gave his knowledge and experience to help them to overcome those difficulties inseparable from governmental control. Although his whole life was devoted to the service of chemistry, he yet found time to act as treasurer of his church for many years. He was kind and generous to his colleagues and lost no opportunity of encouraging those young members of his staff who showed a lively interest in chemistry. His enthusiasm for chemistry remained to the end, when he could still be seen moving from room to room of the Laboratory—asking, suggesting, encouraging.

His services were rewarded by the honour of the OBE in 1920, of the CB in 1938 and of a knighthood in 1944, his services to chemistry were acknowledged by the Royal Society in 1943, when he was elected a fellow. He leaves a widow, a son and a daughter.

A. G. FRANCIS

Sir Percy Nunn

THAT so distinguished a career as that of Sir Percy Nunn should have terminated in a sort of banishment from his native land, and therefore from the scenes and causes to which he had devoted his eminent gifts, must indeed be accounted a tragedy. So long as he was able to spend a few summer months in England, after many months of exile to Madeira for reasons of health, his lot seemed tolerable. But the grim course of world events meant for him complete exile, a condition which, however, his nobility of character enabled him to bear with exemplary patience and fortitude. He died on December 12 at the age of seventy-four.

That Nunn was first of all, at least in the chronological sense, a man of science, is shown by his first substantial piece of writing, his 'Aims of Scientific Method', and by his subsequent work on the nature and teaching of mathematics. It is scarcely too much to say, however, that even then, and still more decidedly later on, when he became an active member of the Aristotelian Society, he was essentially a philosophic thinker. The broad philosophic outlook characterized all his literary work. He wrote a book bearing the modest and not uncommon title 'Exercises in Algebra'. The book must have been a sore puzzle to teachers who had not got far from the 'Hall-and-Knight' tradition. It was, in fact, the result of years of teaching combined with reflexion, and finally of many months of patient and laborious research in the British Museum and elsewhere. It could not be a best-seller in the secondary schools, but it could, and it did, help towards a reorganization of school mathematics.

At a later stage in Nunn's career, he published his well-known 'Education: its Data and First Principles', a work which summed up in brief compass the substance of his courses of lectures on the subject

That book, published two years after the end of the first world war, was, for one thing, a marvel of prophecy as to the shape of things to come. The author's main purpose was "to re-assert the claim of Individuality to be regarded as the supreme educational ideal, and to protect that ideal against both the misprision of its critics and the incautious advocacy of its friends". The book, remarkable both for its clear vision and its massive learning, still stands as the finest systematic defence of the only educational ideal which can make the world safe for democracy.

Some of Nunn's old friends will remember how as vice-principal of the new London Day Training College, he was introduced to them nearly forty years ago, by the principal, the late Sir John Adams, in a rather dingy little room near Holborn which formed the temporary headquarters of the College. These were the roots, the fruits of which are seen to-day in the great University Institute of Education. The development was mostly due to the creative genius of one man, and that man was Percy Nunn. No longer is it necessary that teachers in the British Commonwealth of Nations should go to the United States if they wish to pursue advanced studies in education. They can now get what they want in England, thanks to the efforts of Sir Percy Nunn and to those of his singularly appropriate successor, Sir Fred Clarke.

As the advocate of a cause, Nunn was a persuasive, quiet and eloquent speaker. There was a marvellous flow of language, but every word told. He was true and loyal friend and a delightful companion, and in his exile he liked to recall in his letters the days of small things in a distant past. T. RAYMONT

Mr J Edmund Clark

JAMES EDMUND CLARK died on December 16 at the age of ninety-four. He was the last of the fourteen children of James and Eleanor Stephens Clark. His father died at the age of ninety-four, and the average age of his nine brothers and sisters who reached maturity was more than eighty-two when they died. His mother was one of a family of seventeen children.

Clark was educated at Bootham School, York, a University College, London, and at the University of Heidelberg. He returned to the famous Quaker school for boys at York as junior master during 1869-72, and after further training, he succeeded his life-long friend, later Prof Silvanus P. Thompson as science master at Bootham in 1875. After twenty-two years as a schoolmaster, he gave it up, largely because of deafness, and went to London in 1897 where he began a new career as export merchant. He retired in 1929.

Keenly concerned as Clark was for every branch of natural science, it was meteorology and phenology which particularly claimed his interest. For twenty-five years he was secretary of the Phenological Committee of the Royal Meteorological Society, and was for long a member of the Society's Council. His tribute was paid, when he retired in 1936, to his services to phenological studies on the effect of climatic conditions on natural phenomena.

In 1879 Clark married Lucretia H. Kendall, of Boston, Mass. She died in 1937, as did also their only son, Roderic. Throughout his life, Clark was a devoted and active member of the Society of Friends in York, Croydon, Purley and Street.

NEWS and VIEWS

New Year Honours List

THE following names of scientific workers and others associated with scientific activities appear in the New Year Honours list

Order of Merit · Prof A N Whitehead, professor of philosophy in Harvard University

Baronet · Sir Alfred Webb-Johnson, president of the Royal College of Surgeons

K B E · Sir Stanley Angwin, engineer-in-chief, General Post Office

Knights · Prof L P Abercrombie, professor of town planning, University of London, Dr E B Bailey, director of the Geological Survey of Great Britain, Mr F W Bain, chairman of the Chemical Control Board, Ministry of Supply, Prof J' Chadwick, professor of physics, University of Liverpool, or services to the Department of Scientific and Industrial Research, Dr A P M Fleming, a director of Metropolitan-Vickers Electrical Co, Ltd, or services to education, Mr R G Hetherington, adviser on water and director of water surveys, Ministry of Health, Mr W P Hildred, director-general of civil aviation, Air Ministry, Mr C C Inglis, director of the Indian Waterways Experiment Station, Poona, Prof E H Minns, emeritus professor of archaeology and president of Pembroke College, Cambridge, Diwan Bahadur Arcot Lakshmanaswami Mudaliyar, vice-chancellor of the University of Madras, Dr C W B Normand, lately director-general of observatories, India, Mr J F Rees, principal of the University College of South Wales and Monmouth, Cardiff, vice-chancellor of the University of Wales, Dr R E Stradling, chief adviser, Research and Experiments Department, Ministry of Home Security, Bomanji Jamshedji Wadia, vice-chancellor of the University of Bombay, Brig L E H Whitby, lately bacteriologist at the Middlesex Hospital, for services in the development of the sulphonamide group of drugs, Prof E T Whittaker, professor of mathematics in the University of Edinburgh

C M G · Mr D L Blunt, director of agriculture, Kenya, Mr A R Callaghan, principal of the Roseworthy Agricultural College, South Australia, for public services, Mr G C Turner, principal of the Makerere College, Uganda

C I E · Daulat Ram Sethi, agricultural production and marketing adviser, India, Mr H S George, chief conservator of forests, Central Provinces and Berar, Mr J B T Brooks, chief conservator of forests, Bombay, Mr F C Minett, director of the Imperial Veterinary Research Institute, Izatnagar-Mukteswar, Rai Bahadur Tridib Nath Banarji, principal of the Prince of Wales Medical College, Patna

C B E · Mrs Mary G Blacklock, the Liverpool School of Tropical Medicine, Mr J. P. Bowen, engineer-in-chief to Trinity House, Mr H Campion, director of the Central Statistical Office, Offices of the War Cabinet, Mr H J E Dumbrell, director of education, Bechuanaland Protectorate, Mr R E W. Flower, lately senior deputy keeper of manuscripts, British Museum, Mr J P Bushe-Fox, chief inspector of ancient monuments, Ministry of Works, Major J Keith, chairman of the Board of Governors, North of Scotland College of Agriculture, Mr J R Learmonth, surgical director, Emergency Medical Services, SE Area of Scotland, and professor of surgery, University of Edinburgh, Mr R C Mar-

shall, chief conservator of forests, Gold Coast, Mr W L Taylor, forestry commissioner, Mr R R. Waterer, conservator of forests, Cyprus.

The Next 11-Year Solar Cycle Begins

THE recent appearance of a big sunspot (visible at times to the unaided eye), together with four or five smaller groups overlapping in time, probably signifies that the rise in solar activity towards its next maximum has now definitely begun. This major group of spots in south latitude 22° crossed the sun's disk between December 8 and 20 last, the time of central meridian passage being December 14. A considerable disturbance in the earth's magnetic field occurred on December 16-17, with associated disturbed conditions for long-distance radio communication. For the past eighteen months, high latitude (20°-40°) sunspots have begun to appear in increasing numbers, giving the characteristic overlap seen at this epoch of the 11-year cycle with the decreasing old-cycle spots in equatorial latitudes (0°-10°). The routine observations of the magnetic fields of sunspots, carried out at the Mount Wilson Observatory (*Proc Ast Soc Pacific*, Oct 1944) show that the anticipated reversal of the magnetic polarity of comparable sunspots has taken place with the appearance of the new cycle spots, as first observed by Hale at the sunspot minimum of 1913. Sunspot frequency during 1943-44 gives a minimum at about 1944.5. The rise from minimum to the following peak of the cycle takes on the average 3½-4 years, but individual cycles vary in amplitude and time of phase, not subject to prediction.

Earthquake in Britain

AN earth tremor approximately of scale 4½ on the modified Mercalli scale (scale 5—felt by nearly everyone, many awakened, some dishes, windows, etc., broken, a few instances of cracked plaster, unstable objects overturned, disturbance of trees, poles and other tall objects sometimes noticed, pendulum clocks may stop) in the epicentral region occurred on December 30, 1944, about 12.35 a.m. GMT. It was recorded on Mr J J Shaw's seismograms at West Bromwich, and here the record lasted about two minutes. The seismograph at Stonyhurst College Observatory was unhinged by the shock so that the full record was not obtained. Reports are not yet to hand from other observatories. The tremor was felt by people over a radius of approximately a hundred miles, and was reported from Carlisle, Newcastle, Norfolk, Derby and intermediate places. No damage or casualties have been reported. So far as can be ascertained there was no noise associated with the tremor. In the north of England this was the greatest tremor since the North Sea earthquake (epicentre latitude 53° 7' N, longitude 1° 3' E) of June 7, 1931. A somewhat greater tremor shook Scotland and England on October 23, 1839, when the epicentre was near Comrie.

Mepacrine

AN important statement on the anti-malarial drug mepacrine BP (quinacrine hydrochloride of the United States Pharmacopoeia, also called 'atabrin' or 'atabrin') has been issued by the Medical Research Council's Committee on Malaria (*Brit Med J*, 664, Nov 18, 1944, and the *Lancet*, 667, Nov 18, 1944). In view of the great importance of malaria in warfare in the Far East and the Mediterranean area, a

great deal of work has been done recently on the relative merits of the two chief anti-malarial drugs at present available, namely, mepacrine and quinine. Before the War the world's supply of quinine came almost entirely from Java, and, when the Japanese captured this island, they also cut off practically the whole supply of this essential drug. The Allied Nations turned, therefore, to mepacrine, originally made by the I G Farbenindustrie, which announced its manufacture in 1932. Mepacrine has an acridine nucleus with a long side-chain ending in a substituted amino-group. It may stain the skin yellow when it has been taken by the mouth in large quantities. Its manufacturers stated that its anti-malarial action is as powerful as that of quinine, and this was confirmed during the Ceylon epidemic in 1935. One of the advantages claimed for it was that it is less likely than quinine to cause vomiting or to be followed by blackwater fever, but its action was said to be slower and, in a small proportion of cases, it was apt to cause symptoms resembling those of epilepsy or mania.

The relative merits of the two drugs have now been evaluated. The United States Board for the Co-ordination of Malarial Studies has resolved, as the result of quantitative studies in civilian, Army and Navy establishments, that no advantage, and possible disadvantage, to the Armed Forces would follow if quinine or totaquine U.S.P. (which is a product containing cinchona alkaloids with an activity approximately equal to that of quinine) replaced mepacrine for the routine suppression and treatment of malaria, that the large-scale production of quinine or totaquine is not now important for the management of malaria in Army and Naval personnel, although increased supplies of totaquine may be required for civilians temporarily controlled by the Armed Forces, and that there will be, after the War, a continued great need for anti-malarial drugs. The Medical Research Council's Committee on Malaria endorses these conclusions and agrees in general with the American views. This Committee says that mepacrine, under proper administration, is no more liable to cause toxic effects than is quinine, and that mepacrine is not an inferior substitute forced upon us by the Japanese occupation of Java, it is a more effective anti-malarial agent which would still be used if the supplies of quinine were unlimited.

Child Health

THE City Council of Liverpool together with the University and the Merseyside Voluntary Hospitals have combined to finance a chair of child health, which was opened on October 27 last (*Lancet*, 608, Nov. 4, 1944). This new department will teach the subject to undergraduates and, in postgraduate courses, to medical men. Liverpool thus follows the lead given by Edinburgh as long ago as 1931. The generosity of the Nuffield Foundation has made possible the creation of a chair of child health in London, where a postgraduate institute is to be created in association with the Hammersmith Postgraduate Medical School and the Great Ormond Street Hospital for Sick Children (*Brit Med J*, 410, Sept. 23, 1944). The Nuffield Provincial Hospitals Trust has also assisted the endowment of a chair of child health at King's College, Newcastle-upon-Tyne.

It is clear that the children of the future are to be attended by medical men who have had more training in the diseases of children than practitioners now obtain. The health of their mothers is already the

subject of much instruction and organization, and will also, it is to be hoped, be a prominent feature of medical work of the future. The Children's Nutrition Council hopes to see, after the War, a campaign among housewives about foods and food-habits.

Immigration in the British Commonwealth

A P.E.P. broadsheet, "People for the Commonwealth" (No. 226), gives a review, with statistical appendix, of prospects for migration to the Dominion. The broadsheet concludes that the sparsely populated Dominions would benefit from a marked increase in population. Their standard of living would thereby be higher and their military security buttressed. Natural increase is bound to be slight, even if the decline in fertility in the Dominions can be checked and even if death-rates continue to fall. There is no alternative to immigration, and it has been estimated that Canada should have 50 instead of 11.5 million people, Australia 20 instead of 7 million, South Africa 5 instead of 2.5 million white people, New Zealand 5 instead of 1.5 million. In the past, non-British immigration has been rigidly restricted to safeguard the British character of the Dominions, which still want British emigrants. All the Dominion Governments are receiving applications from people who want to leave Britain, but such discrimination will in future be incompatible with a large volume of immigration, since there are not likely to be many British emigrants after the War, nor will there be many from the other nationalities which have traditionally been preferred. In the inter-war period Britain assisted emigrants to the Dominions. If such assistance is once again given after the War and evokes substantial response, the imminent decline in British population will be hastened, and in view of its ageing population, Britain's own standard of living will thereby be prejudiced and the task of reversing the decline made more difficult. If immigration from Asia is excluded, the only remaining source will be the countries of southern and eastern Europe, and there is no reason for thinking that, given time and expansionist economies in the Dominions, nationals of these countries could not be successfully absorbed.

Michigan Academy of Science, Arts and Letters

VOLUME 22 of the Michigan Academy of Science, Arts and Letters contains communications upon a wide range of subjects including, *inter alia*, forestry, geography, anthropology, history and philosophy. (Papers of the Michigan Academy of Science, Arts and Letters, Vol. 28 (1942). Pp. xiii+701+5 plates. Ann Arbor, Mich.: University of Michigan Press; London: Oxford University Press, 1943. 28s. net). Most of the botanical papers deal with the determination of species in the lower plants. There is an ambitious and critical monograph on the *Leucopaxillus* (toadstools) by R. Singer and A. E. Smith with chemical and microscopical data. Several papers deal with tropical marine Algae, and a number of new Red Algae are described. G. W. Prescott and A. M. Scott give about a hundred good line drawings of American forms of *Microsterias* (a desmid), including many known in Britain and several new ones. Finally may be mentioned a charming little paper on the pollen of a Swedish bog by E. Jansson and I. Halpert, who wondered whether the European faun could be as clear-cut as have been reported, but found they were so. The zoological papers deal with various topics from Arthropods to reptiles. It is known that

the common garter snake of North America in the spring. F. C. Blanchard investigated the matter more fully and found evidence to show that effective mating occurs commonly in the autumn in the wild state. The offspring from such matings, if the females are kept isolated, exhibit normal Mendelian ratios in their colour pattern. In the wild, such females may copulate again in the spring and the resulting offspring show colour patterns that bear no relationship to any Mendelian ratio, and so it would appear that the actual insemination resulting from the autumn mating does not occur until after the spring mating. J. C. Beckman shows that in a number of game fishes in Michigan, temperature plays the leading part in the annulus formation in the scales. The mean temperature of the first days on which the majority of the scales showed an annulus is 58° F. An interesting paper by C. L. Hubbs and R. R. Miller deals with the influence of changed environment upon inter-specific hybridization of two generations of Cyprinodont fishes.

Quality Control Technique

A USEFUL booklet entitled "Quality Control Chart Technique when Manufacturing to a Specification", by B. P. Dudding and W. J. Jennett, has recently been published by the General Electric Co., Ltd., of England (Research Laboratories, G.E.C., Wembley, s. 6d.). The booklet describes a more detailed development of the principles discussed in British Standard 00 R (1942), and the major aim of the technique described is to assist production to specification requirements with the elimination of waste labour and material. While the handbook is intended principally as a guide for those concerned with the machine manufacture of articles to dimensional limits, it should be helpful to anyone introducing the technique for use in other types of manufacture. The book is arranged in two parts with appendices. Part 1 deals with quantitative data and is concerned with the utilization of results of measurement. Part 2, giving qualitative data, is concerned with the utilization of the results of classifying a product into categories as, for example, 'defective' and 'effective'. Suggestions are made with the view of increasing the value of control charts for number defective in those cases where this method has to be adopted or it is preferred on grounds of convenience and/or cost.

Production Control in Industry

UNDER the title "Production Control in the Small Factory: Office Aid to the Factory" (B.S. 1100. Part 1, 1944), the British Standards Institution has issued a booklet designed to advise on production control technique in the small factory. The need is stressed for control in order to make it possible economically to increase production and to eliminate waste of time and effort. The practice and procedure recommended are illustrated by taking as example a firm in which between fifty and sixty people are employed in the manufacture of jigs and fixtures for small assemblies. The number of schedules, records and documents is kept down to the minimum for simple control over such quotations, purchasing and stock, volume of work to be handled, flow of work to shops, production instructions, time-keeping and costs. The methods described are illustrated with specimen schedules, cards, record sheets, and a comprehensive order flow

chart, which shows the various stages through which an order will pass. By careful study of these recommendations, factory managers should be able to adapt them to their firm's individual needs.

Lighting Reconstruction

THE Illuminating Engineering Society has now issued the fifth of the series of its Lighting Reconstruction Pamphlets, the present one dealing with city and highway public lighting. The pamphlet discusses what might well be done in the way of public lighting in the post-war period, and it offers useful guidance, with the view of achieving maximum benefit to those concerned. The pamphlets are obtainable from the Society at 32 Victoria Street, London, S.W.1, at the uniform price of 1s. each, 9s. a dozen or £3 a 100.

Announcements

MR. GEORGE SMITH, of the London School of Hygiene and Tropical Medicine, has been elected president of the British Mycological Society for 1945.

AT the meeting of the London Mathematical Society on January 25, at 3.0 p.m., in the rooms of the Royal Astronomical Society in Burlington House, Prof. J. Hadamard, of the Paris Academy of Sciences, will give his postponed lecture "Psychological and Personal Recollections of a Mathematician". Members of other scientific societies will be welcome.

A COMPREHENSIVE review of progress in industrial and medical radiology is contributed by Bernard John Leggett to the November issue of the *Journal of the Institution of Electrical Engineers* (91, Part 1, No. 47). The paper reviews atomic physics, the cyclotron and betatron, the generation of high voltage and design of high-voltage X-ray tubes, industrial radiology, medical radiology and bio-electric phenomena. A bibliography of sixty-seven items accompanies the paper.

AN Annotated Bibliography of Medical Mycology, edited by Dr. S. P. Wiltshire, in collaboration with Dr. Charles Wilcocks and J. T. Duncan (Imperial Mycological Institute, Kew, Surrey, 1944. Pp. 32. 5s.), lists all papers on medical mycology which were either published in 1943 or noted by abstracting journals during that year. Authors and subjects are indexed. Short summaries follow most of the headings. If these summaries can be enlarged in future years, the value of this publication will be greatly enhanced. The Bibliography can be recommended as a work of reference for dermatologists and pathologists.

CATALOGUE 63 of scientific books issued by Ifan Kyrle Fletcher, "Merridale", Caerleon, Mon., contains among others the following works of interest: Andrea Bacci's "De thermis libri system" (1571), Bateman's "Practical Synopsis on Cutaneous Diseases" (1824), first edition of Sir Thomas Browne's work (1686), Cheselden's "Anatomy of the Human Body" (1741), Cornaro's "Discourse on a Sober and Temperate Life" (1779), Fabricius ab Aquapendente's "Opera omnia anatomica et physiologica" (1687), John Freind's "Opera omnia" (1723), Sir John Harrington's "Metamorphosis of Ajax" (1814), J. F. C. Hecker's "Epidemics of the Middle Ages" (1846), "Lunacy Acts" (1798-1824) and Mesué's "De re medica" (1542).

LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications.

Existence of Time-dependence for Interfacial Tension of Solutions

In a recent note under this title, Ward and Tordai¹ have pointed out that the interfacial tension between water and hexane solutions of lauric acid attains equilibrium at an anomalously slow rate, and suggest that this arises from a process of high activation energy being involved subsequent to the diffusion of solute molecules to the interface. The observed marked effect of temperature in hastening equilibrium was taken as support for this view.

Slow accumulation at an interface has been much discussed recently, and this further very interesting example would appear to be closely related to the slow ageing of surface tension of hydrocarbon solutions of dedecyl sulphonic acid². A suggestion put forward to explain this latter phenomenon ascribed it to the slow breakdown at the surface of the strongly associated solute molecules³, since on general grounds strong molecular association would be expected in such hydrocarbon media.

A somewhat similar picture may hold for the lauric acid/hexane system with its well-known monomer-dimer association. The polar groups in the dimer would be largely screened by the randomly kinked fatty-acid hydrocarbon chains, and on collision of the dimer with the interface could but seldom approach the aqueous phase sufficiently closely for interaction, and hence for the subsequent dissociation and re-orientation, to occur. As a first approximation, therefore, the dimer *per se* might be regarded as completely ineffective for bringing about equilibration. With the monomer, this particular restriction clearly would not exist, and the observed slow rate of equilibration would then arise from the small proportion of fatty acid existing in the monomeric state, which in hexane solutions would be expected to be very low indeed. (Even with the monomer a considerable proportion of the collisions with the surface would be ineffective owing to the large size of the hydrocarbon chain relative to that of the carboxyl group, but this can be estimated and is unlikely to be less than 10^{-2} .)

If this picture is correct, the time required for interfacial equilibrium should decrease with decreasing molecular association in the hydrocarbon medium. Accordingly solutions in nujol, in benzene and in nitrobenzene, of palmitic acid and of an oil-soluble detergent ('Aerosol OT', from the British Cyanamid Co.), have been studied, and the times for equilibration are found to decrease from several days with nujol to a few hours or minutes with nitrobenzene. No equilibrium constants for the association of fatty acids in nujol appear to be available, but it is certain that the extent of dissociation into monomer would increase in the above order⁴.

The marked temperature coefficient observed is then readily explained as arising from the high ΔH value for the monomer-dimer association reaction, which is about 16.5 Cal. in the gas phase⁵, greater than 9.7 Cal. in benzene⁶, and about 6.0 Cal. in nitrobenzene⁷.

This suggested explanation, if confirmed by further work, would provide another means of estimating

the degree of association of polar compounds in hydrocarbon media, and the values of equilibrium constants and heats of association. It should be particularly useful for cases showing high association constants and for compounds insoluble in water where the usual methods based upon freezing point, infra-red absorption spectra and distribution, are not suitable.

A. E. ALEXANDER.
E. K. RIDEAL.

Colloid Science Department,
University, Cambridge.
Nov. 28.

¹ Ward and Tordai, *Nature*, **154**, 146 (1944).

² McBain and Perry, *J. Amer. Chem. Soc.*, **62**, 989 (1940).

³ Alexander, *Trans. Far. Soc.*, **37**, 15 (1941).

⁴ Francois, *C.R. Acad. Sci.*, **193**, 1008 (1931). Broughton, *Trans. Far. Soc.*, **30**, 367 (1934).

⁵ "Int. Crit. Tables", **7**, 246 (acetic acid).

⁶ Moelwyn-Hughes, *J. Chem. Soc.*, 850 (acetic acid).

⁷ Private communication from Dr. M. M. Davies (propionic acid).

Photographic Fourier Synthesis

In 1929, Sir Lawrence Bragg¹ showed that electron density projections and Patterson projections of crystal structures could be synthesized by the photographic addition of patterns of light and dark bands of proper period and orientation, one pattern for each term in the series. Later², I showed that such syntheses can be made easily and rapidly if one has available a set of suitable masks. These are inserted successively into a photographic enlarger and exposures made through them, the exposure times being proportional to the F or F^2 values—the coefficients of the individual terms in the series.

In making an electron density projection, the desired summation is

$$\sum_{hk} F_{hko} \cos 2\pi (hx + ky),$$

where x and y are co-ordinates in the projected unit

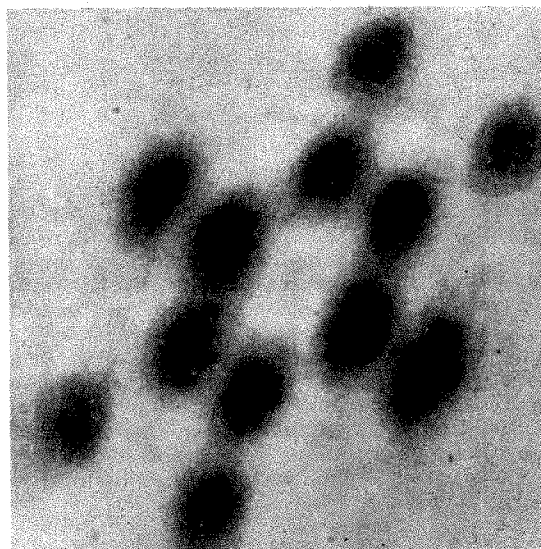


Fig. 1. PHOTOGRAPH OF A HEXAMETHYLBENZENE MOLECULE OBTAINED BY PHOTOGRAPHIC FOURIER SYNTHESIS FOR X-RAY DATA BY BROCKWAY AND ROBERTSON³.

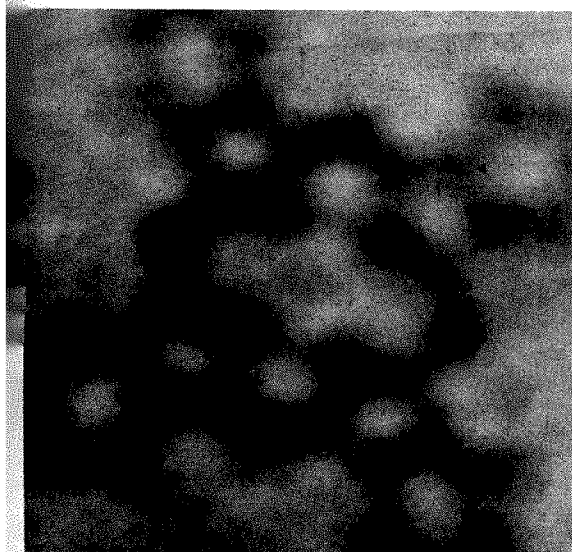


Fig. 2. PHOTOGRAPH OF A PHTHALOCYANINE MOLECULE, FROM X-RAY DATA BY ROBERTSON¹.

ll. If the distribution of light transmission through each mask is

$$1 + \cos 2\pi(hx + ky),$$

the total light intensity reaching the photographic emulsion (on which the picture is being made) is the desired summation plus a uniform, unwanted background. The effect of this uniform background illumination can be nearly eliminated by using a photographic material—such as Velox F5, Kodalith paper or Kodalith film—with a suitable characteristic curve. Although not necessary for crystal structure analysis, the remaining background can be entirely removed by treatment with a reducer solution or by reprinting, using appropriate film and paper.

With the aid of the Physics Department of these laboratories, an improved set of masks has recently been made, on a roll of 35 mm. film. Examples of syntheses obtained with these new masks are shown in the accompanying figures. In Fig. 1 the background has been partly removed by reprinting.

The departure from a perfect hexagonal structure in Fig. 1 is in part due to inclination of the molecule relative to the plane of the projection, and in part to the representation of the actual unit of the projection—a parallelogram with unequal sides and angles—by a square. In Fig. 2 these two factors practically cancel each other, the photograph showing the appearance of the phthalocyanine molecule with the line of vision normal to the plane of the molecule. If wanted, projections having the shape of the true unit can be produced by any of several procedures, now in process of being tested here.

We hope soon to be able to furnish copies of these masks, at a nominal cost, to others doing crystal structure work.

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Oct. 9.

Bragg, W. L., *Z. Krist.*, **A**, **70**, 475 (1929); "The Crystalline State" (New York, Macmillan, 1934), p. 229.

Huggins, M. L., *J. Amer. Chem. Soc.*, **63**, 66 (1941).

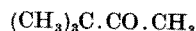
Brockway, L. O., and Robertson, J. Monteath, *J. Chem. Soc.*, 1324 (1939).

Robertson, J. M., *J. Chem. Soc.*, 1195 (1936).

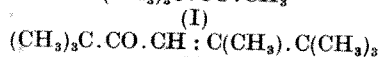
Grignard Compounds as Condensing Agents

It is already known that Grignard compounds may act as reducing agents^{1,2}, or cause enolization of ketones^{3,4}, or bring about the condensation of esters of some fatty acids to β -keto-esters. The present communication records some observations on the condensation of ketones during the Grignard reaction.

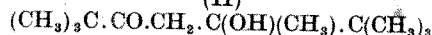
It was observed during the preparation of some tertiary alcohols by reaction of alkylmagnesium halides with ketones that the product contained greater or smaller amounts of condensation product. Thus pinacolin (I) and *tert.*-butyl magnesium chloride gave as principal products, pinacolyl alcohol and a mixture of the hydroxy ketone (III) and the unsaturated ketone (II). None of the required alcohol could be isolated. Ethyl magnesium bromide also gave notable amounts of these condensation products, as did also phenyl magnesium bromide.



(I)



(II)



(III)

A survey of the literature has shown that the formation of condensation products from ketones during Grignard reactions has been frequently recorded without any further characterization or identification¹. Only two recorded examples of the identification of such products have so far come to our notice^{2,5}. It would now appear that the self-condensation of ketones during the Grignard reaction is more general than is commonly supposed, and that by selecting suitable reactants it may become the main reaction.

The experimental data at present available leads to the conclusion that alkyl magnesium halides with highly branched chains not only bring about reduction of the ketone but also promote condensation. The structure of the ketone is also an important factor; those with an available hydrogen adjacent to the carbonyl and a slow rate of reaction towards Grignard reagents condense more readily. If they react with Grignard reagents which do not cause reduction, such as the aryl magnesium halides, the formation of the condensation is still more favoured.

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¹ Conant and Blatt, *J. Amer. Chem. Soc.*, **51**, 1227 (1929).

² Whitmore *et al.*, *J. Amer. Chem. Soc.*, **63**, 648 (1941).

³ Grignard and Savard, *Bull. Soc. chim.*, **35**, 1081 (1924).

⁴ Kohler, Stone and Fuson, *J. Amer. Chem. Soc.*, **49**, 3181 (1927).

⁵ Tolstopyatov, *J. Russ. Phys. Chem. Soc.*, **62**, 1813 (1930).

Rates of Oxidation of Different Substrates in the Frog's Liver

In the course of preliminary studies in an investigation regarding the mechanism of the regulation by hormones of enzymic processes, we have carried out determinations of the respiratory quotient (*RQ*) of the liver tissue with homogeneous material from the frog (*Rana temporaria*) in the summer state. For each specimen a determination of respiratory quotient was performed on slices by a modification¹ of the method of Meyerhof and Schmitt. The values obtained varied between 0.70 and 1.00. When the values of the oxygen consumption per mgm. fresh weight were

correlated with the corresponding values of the respiratory quotient, it was found that high values of the latter were accompanied by low oxygen consumptions and vice versa. It follows that different substrates occurring in the liver of the frog are oxidized at different rates.

A more detailed account of the results will shortly be published elsewhere.

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Winberg, H., *Ark. Zoologi*, **32** A, No. 7 (1939). Ödman, L., *Ark. Zoologi*, **32** A, No. 15 (1940).

Effect of Anoxia on Excitation and Impulse Propagation in Isolated Motor Nerve Fibres

ALTHOUGH the paralysing action of anoxia on peripheral nerve has been frequently studied in previous investigations, so far as we know, no attempt has as yet been made to examine whether excitability and propagation of the nervous impulse react identically to lack of oxygen.

Monophasic action potentials of isolated motor nerve fibres (sciatic nerve of *Rana esculenta*) were used as indicators. The nerve was placed in a moist chamber consisting of two separate sections, one containing two platinum electrodes for stimulation with condenser discharges, the other two silver-silver chloride electrodes for leading-off action potentials. Care was taken to avoid stimulus escape and to provide constant resistance between the leading-off electrodes. Anoxia was produced by passing a moist stream of purified oxygen-free hydrogen through each section of the chamber.

When anoxia is applied to both the stimulated and the conducting region of the nerve fibre, the average time necessary to suppress activity is 34 minutes, while it takes more than 70 minutes when anoxia is limited to the leading-off section of the chamber. This difference is statistically highly significant. The action potential reappears immediately after readmission of oxygen with reduced amplitude and without a positive after-potential. After 15 minutes in oxygen it has regained its original shape and amplitude. The stimulated region of a peripheral nerve fibre is thus far more sensitive to anoxia than its purely conducting parts, a difference which might be of interest in the interpretation of the mechanisms of excitation and propagation.

A further discussion on the matter is to be published elsewhere.

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Toxicity of Adrenaline

UNHEATED solutions of adrenaline quickly acquire a coloration if exposed to air or oxygen for a short period of time. Sodium or potassium metabisulphite has been proposed as an antioxidant for such solutions¹, and the U.S. Pharmacopeia XII permits the use of reducing agents such as sodium bisulphite up to concentrations of 0.5 per cent. The effect of this

substance on the toxicity of adrenaline was investigated in the United States², and an increase of more than 100 per cent subcutaneously and more than three times intramuscularly was shown when tests were made on mammals. But no reference was made to the toxicity of adrenaline solutions containing metabisulphite after heat treatment, for example, autoclaving. These heated solutions, provided the pH adjusted, have already been found to have lost very little activity, and to be sterile and colourless¹.

Solutions of adrenaline (1/1,000) in hydrochloric acid, with a final pH of about 3.0, were therefore prepared with and without 0.1 per cent of potassium metabisulphite, and their toxicities were tested on rats and frogs. The solutions containing metabisulphite were divided into two parts, and one was put in an ampoule and heated at 115° C. for 30 minutes. The rats were injected subcutaneously, the solutions containing 0.9 per cent sodium chloride; the frogs received their doses into the lymph sac; the solutions containing 0.6 per cent sodium chloride. The approximate values for LD 50 (in mgm. per kgm) were as follows: (a) rats—subcutaneously; adrenaline 12, adrenaline with metabisulphite 6, adrenaline with metabisulphite heated 14; (b) frogs—lymph sac; adrenaline 75, adrenaline with metabisulphite 30, adrenaline with metabisulphite heated 60.

Totals of sixty frogs (both sexes) and a hundred rats (all male) were used to obtain these values. These are relatively small numbers, but the results are important and more detailed work is in progress. Metabisulphite more than doubled the toxicity of adrenaline, thus confirming previous results²; but on heating these solutions in 10-ml. ampoules, the tendency was to return to the toxicity figures of the plain solution. Other experiments have been carried out using metabisulphite solutions (0.1 per cent and 0.9 per cent sodium chloride), heated adrenaline solutions, and heated metabisulphite solutions, but no significant results were obtained.

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¹ Berry and West, *Quart. J. Pharm.*, **17**, 242 (1944).

² Richards, *J. Pharmacol.*, **70**, 111 (1943).

Absolute Scotopic Sensitivity of the Eye in the Ultra-violet and in the Visible Spectrum

In a paper published in 1941¹ measurements were given of scotopic and photopic sensitivity, for which nine observers were used. These measurements were made in the range between the mercury lines 70 and 302 mμ. In the paper by Goodeve, Lythgoe and Schneider published in 1942² measurements were given of scotopic sensitivity, for which six observers were used, including one with an aphakic eye. The measurements were made at the mercury lines 365 and 546 mμ. It is of interest to compare the results obtained after dark adaptation of one hour with the results of Goodeve *et al.*, obtained after dark adaptation for 10 minutes.

The absolute scotopic sensitivity, S_λ , in terms (quanta/sec. sq. mm.)⁻¹ is related to the illuminance of the pupil, E_λ (the latter being expressed in terms of erg./sec. sq. cm.), by the equation

$$S_\lambda = \left[\frac{E_\lambda \times 10^{-2} (1 - r)}{h\nu} \cdot \frac{\sigma}{a} \right]^{-1},$$

where r represents the reflexion losses at the cornea of the eye (assumed to be 0.05), σ the area of the pupil (assumed to be dark-adapted and equal to 0 mm.²), and a the area of the image on the retina 1 mm.². The area of the image a was 0.0088 mm.².

The accompanying table shows the comparison between our measurements of scotopic sensitivity and those of Goodeve *et al.*

Observers and their age			log S_{335}		log S_{345}		log S_{345}/S_{335}	
2nd 1st group	Pine-gin	Good-eve <i>et al.</i>	Pine-gin	Good-eve <i>et al.</i>	Pine-gin	Good-eve <i>et al.</i>	Pine-gin	Good-eve <i>et al.</i>
	1 (17)	A (20)	-7.8	-7.5	-3.9	-4.1	+3.9	+3.4
	2 (19)	E (42)	-9.2	-9.8	-5.3	-5.0	+3.9	+4.8
	3 (15)	—	-8.4	—	-4.8	—	+3.6	—
	4 (19)	B (27)	-8.7	-8.8	—	-4.3	—	+4.5
	5 (37)	D (34)	-8.3	-8.3	-4.9	-4.4	+3.4	+3.9
	6 (22)	C (27)	-7.7	-7.7	-3.8	-4.2	+3.9	+3.5
	7 (25)	—	-8.6	—	-5.0	—	+3.6	—
	8 (21)	—	-7.9	—	-4.9	—	+3.0	—
	9 (29)	—	-7.8	—	-5.1	—	+2.7	—
Mean values		—	-8.5	-9.2	-4.9	-4.5	+3.6	+4.7
Mean values without <i>E</i>		—	—	-8.3	—	-4.3	—	+4.0
Mean values for the first group		—	-8.8	—	-5.0	—	+3.8	—
Mean values for the second group		—	-8.3	—	-4.8	—	+3.5	—
—		<i>F</i> (26) (aphakic)	—	-4.2	—	-4.2	—	0.0

The absolute scotopic sensitivity in the ultra-violet was found to have greater individual variations, as some of the observers have maximum sensitivity at 334 m μ , and others have a flattening of the curve at 334–365 m μ . The value S_{335} for most observers in my investigations and in those by Goodeve *et al.* varies approximately in the same limits. Two of the observers in both cases have an equal sensitivity. But the mean value of S_{335} according to Goodeve *et al.* is considerably lower than the same value for the first and second group or for all the observers, in my case. If we exclude the data given by these authors for the eye with the lowest sensitivity, the mean value of S_{335} will be nearly the same for all my observers and equal to the mean value for the second group.

The mean value of S_{345} , according to Goodeve *et al.*, is 2.5 times my value. Therefore the threshold retinal illumination according to these authors was about 35,000, while according to my measurements was about 85,000 quanta/sec. sq. mm.

This divergency can be explained by the difference in the area of the image on the retina (0.0088 mm.² in my case and 0.42 mm.² in the case of Goodeve *et al.*). Therefore the value of S_{345} , according to Gassovsky, Khokhlova and Bourago², must, in the case considered by Goodeve *et al.*, be twelve times my value. A considerable difference in adaptation could compensate for this divergency (up to 2.5 times). As a result, the mean value of the ratio S_{345}/S_{335} in my experiments was equal to 4,000, while in those of Goodeve *et al.* (excluding the observer with the lowest sensitivity) it was 10,000.

Thus the measurements of the scotopic sensitivity of the normal eye in the ultra-violet and in the visible spectrum, obtained by these authors, are in agreement with my results and fully confirm the latter.

The absolute scotopic sensitivity of the aphakic eye, according to Goodeve *et al.*, as could have been expected, was found to be the same at 365 m μ as at 546 m μ . This fact, in particular, confirms the measurements of the light fluctuation, made by S. I. Vavilov, including the presence of a maximum of retinal sensitivity at 3800 Å.^{4–11}

Goodeve *et al.* consider 309 m μ as the limit of vision of the normal eye and 298 m μ as that of an aphakic eye. Nevertheless, even at 302 m μ I was able to carry out the measurement not only of the scotopic, but also of the photopic, sensitivity of the normal eye.

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¹ Pinegin, N. I., *C.R. Acad. Sci. de l'URSS.*, **30**, 3 (1941). A detailed account of these investigations is published in "The Problems of Physiological Optics" (*J. Acad. Sci. U.S.S.R.*, **2** (1943)).

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³ Gassovsky, L. N., Chochlova, A. N., Byrango, A. N., *Trudvi Leningradskogo Instituta Technol. Mehaniki Optiki*, **1**, No. 4 (1940).

⁴ Brumberg, E., and Wawilow, S., *Bull. Acad. Sci. URSS.*, série math., **919** (1933).

⁵ Brumberg, E., and Wawilow, S. I., *C.R. Acad. Sci. URSS.*, **3**, 1 (1934).

⁶ Wawilow, S. I., *Trans. Conf. Physiol. Optics*, Leningrad (1936).

⁷ Wawilow, S. I., *Bull. Acad. Sci. URSS.*, série phys., Nos. 1–2, 176 (1936).

⁸ Wawilow, S. I., *C.R. Acad. Sci. URSS.*, **21**, No. 8 (1938).

⁹ Brumberg, E. M., Vavilov, S. I., and Sverdlov, Z. M., *J. Phys.*, **7**, No. 1, 1 (1943).

¹⁰ Vavilov, S. I., and Timofeeva, T. V., *J. Phys.*, **7**, No. 1, 9 (1943).

¹¹ Vavilov, S. I., and Timofeeva, T. V., *J. Phys.*, **7**, No. 1, 12 (1943).

Large Contact Angles of Plant and Animal Surfaces

THE large values given by Fogg¹ for the contact angles of water with leaves suggest that these are apparent rather than true contact angles. Adam² and Wenzel³ have shown that rough surfaces give an apparent contact angle which is greater than the true contact angle for the smooth material of the surface when the true contact angle is greater than 90°. We have recently extended this theory to porous surfaces⁴, and to surfaces so rough that much air is entrapped at the interface between the water and the solid; large apparent contact angles are then possible when the true contact angle is even less than 90°. The apparent contact angle is given by

$$\cos \theta_D = f_1 \cos \theta - f_2, \dots (1)$$

where θ_D is the apparent or observed contact angle, θ is the true angle, f_1 is the area of solid–water contact and f_2 is the area of air–water contact per unit superficial area of the interface.

The exposed surface of ducks' feathers has a ratio for f_2 to f_1 of around 5, and although the advancing contact angle for the material of the feather is no more than 90°, and the receding one 65°, the apparent angles are both around 150° because of the large value of $f_2 : f_1$. Thus, 'water always runs off a duck's back' because of the structure of the feather rather than because of an exceptional proofing agent.

The mirror-like reflexion of raindrops on leaves, particularly noticeable with broccoli leaves, must be due to total reflexion at an air layer between the

water and the continuous surface of the leaf. The degree of perfection of the mirror indicates that here, too, the ratio of f_2 to f_1 must be great, and the values of the observed contact angles will be largely determined by this ratio. The diurnal and wilting variations observed by Fogg are therefore more likely to be due to changes in the physical structure of the leaf cuticle with its water content than to changes in the material of the cuticle.

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¹ Fogg, *Nature*, **154**, 515 (1944).

² Adam, "Physics and Chemistry of Surfaces", 186 (3rd ed., Oxford, 1941).

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Presence in Raw Cow's Milk of a Bactericidal Substance Specific for Certain Strains of Coliform Organisms

DURING the course of an investigation as to the reason why certain strains of coliform organisms when inoculated into raw 'sterile' milk did not reduce methylene blue or resazurin, it was found that these organisms were actually destroyed in milk held at 37° C. for six hours¹. As all the tests for the presence of a bacteriophage in the raw milk were negative, it was considered that the destruction of the organisms might be due to a specific bactericidal substance in the milk. The destruction of the organisms appeared to be closely correlated with the temperature at which the milk was held, so it was considered that the substance was probably not thermostable and further work was undertaken to find out the effect of heat on the substance. To do this, 'sterile' raw milk which had been heated to temperatures varying from 52° to 53° C. for half an hour was inoculated with young broth cultures of the susceptible strains of coliform organisms, so as to give an approximate inoculation count on MacConkey's agar of 500,000–2,000,000 organisms per ml.

Plate counts on MacConkey's agar were carried out at inoculation, and after holding the inoculated milk in a water-bath at 37° C. for four hours, with the following results:

Temperature to which milk was heated (for half an hour) before inoculation		Count per ml. at inoculation	Count per ml. after 4 hours at 37° C.
Culture No. 1	52° C.	1,328,000	1,000
	53° C.	848,000	40,000,000
Culture No. 2	52° C.	316,000	31,000
	53° C.	640,000	28,000,000

From these results it would appear that the bactericidal substance is completely destroyed by heating to 53° C. for half an hour, and that this destruction is critical to within 1° C.

All the cultures of susceptible coliform organisms were originally obtained from raw milk which the presumptive coliform test showed to contain coliform organisms in 1/1,000 ml. but which did not reduce methylene blue or resazurin after six hours incubation at 37° C.

The organisms were tested by the recognized differential tests to find if they conformed to any particular type, and the results of these tests showed

that the majority of the organisms were intermediate types.

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¹ Morris, C. S., *J. Dairy Res.*, **13**, 115 (1943).

'Marsh Spot' in Beans

THE condition known as 'marsh spot' in peas has been proved by Piper¹, using water cultures, to be due to manganese deficiency. An analogous condition in two varieties of broad beans (Wooster Mammoth and Jarvis) used for seed has been observed in the field in the United States by Orton and Henry², who suggested that it resembled 'marsh spot' in peas, and by Furneaux and Glasscock³ in broad beans grown for seed on Romney Marsh. Similar symptoms in runner bean seeds submitted by a seed firm have been reported by Pethybridge⁴, who suggested manganese deficiency as a possible cause, and by De Bruijn⁵ at the Dutch Seed Testing Station in crops grown for seed.

During 1944, peas, *Pisum sativum* (var. Duplex), broad beans, *Vicia Faba* (var. Exhibition Longpod), runner beans, *Phaseolus multiflorus* (var. Scarlet Emperor) and French (dwarf) beans, *Phaseolus vulgaris* (var. Masterpiece), were grown at Long Ashton in manganese-deficient sand cultures, using a refined pot-culture technique, and the pods left on the plants until dry before harvesting. Examination of the seeds revealed typical severe 'marsh spot' in the peas, and mild to severe stages of a 'marsh spot' type of symptom in broad beans and runner beans, as illustrated; the middle of each cotyledon was sunken, brown and pithy, and the embryo in beans frequently showed browning of the plumule as noted by De Bruijn⁵ in peas. The dwarf beans remained free from any signs of 'marsh spot'.

Typical leaf symptoms⁶ (pale green, resembling a low nitrogen condition, with some faintly chlorotic mottling in runner beans and a more marked chlorotic mottling followed by severe intervenal necrosis and withering in dwarf bean) were developed, and



TYPICAL MARSH SPOT SYMPTOMS IN (ABOVE) RUNNER BEANS, (MIDDLE) BROAD BEANS, AND (BELOW) PEAS.

numerous pods failed to fill after setting. Broad beans, as with peas, normally show only a faint interveinal chlorosis of the leaves and the symptoms are not striking.

In a field trial in 1943, peas and broad beans (var. Exhibition Longpod) growing in an acutely manganese-deficient market garden soil in Bristol were examined and showed symptoms of the 'marsh spot' type in stages ranging from mild to severe. Similar material examined in 1944 showed severe 'marsh spot' in the peas and only mild symptoms of this trouble in the beans. Runner beans (Scarlet Emperor), dwarf beans (Prince and Masterpiece), a haricot bean (Comtesse de Chambord) and a tick bean included in the trial showed no symptoms in the cotyledons. The typical leaf symptoms were especially severe in the dwarf beans and in the haricot beans, in which the symptoms resemble those of the dwarf bean.

Leaf symptoms in these trials have been prevented and cured by spraying the leaves with an aqueous solution of manganous sulphate (0.25 per cent solution of $\text{MnSO}_4 \cdot 4\text{H}_2\text{O}$). The results show that whereas peas are very susceptible to manganese deficiency, as shown by the severity of 'marsh spot', broad and runner beans are more resistant to this form of injury, whereas dwarf beans and haricot beans, which show the most marked leaf symptoms, are most resistant and may remain free from 'marsh spot' even when the leaf symptoms are very severe.

Some details of this and related work carried out under the Agricultural Research Council scheme for plant nutrition have already appeared, and a further report is in course of preparation⁷.

I wish to make acknowledgments to the Agricultural Research Council for permission to publish this note and to Mr. G. H. Jones for taking the photograph.

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Piper, C. S., *J. Agric. Sci.*, **31**, 448 (1941).

Orton, E. R., and Henry, W. D., *Phytopath.*, **25**, 726 (1935).

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Wallace, T., "The Diagnosis of Mineral Deficiencies in Plants", and supplement in the press (London: H.M.S.O., 1943).

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Fluorescein-induced Parthenocarpy

PARTHENOCARPY can be induced in, among other plants, the common edible members of Solanaceae and Cucurbitaceae by artificial treatment of the unfertilized ovary with pollens of a different family¹, pollen extracts^{2,3}, many growth-promoting substances such as indole-acetic acid^{3,4}, and even manganese salts⁵. Of the inducing agents so far employed, including manganese salts, have been shown either to contain auxin or to be auxin-like in their physiological activities. These facts have led to the hypothesis proposed by Gustafson³ that growth hormones are essential for the initiation and maintenance of fruit development, and recent experimental evidence seems to support this view⁶. While there is no doubt that growth hormones, defined as they are, play a dominant part in fruit development, it is still a question whether auxins or auxin-like substances alone can induce parthenocarpy; for we have been able to



Left: PARTHENO-CARPIC FRUIT.
Right: NORMAL CUCUMBER.

induce parthenocarpy in members of these two families with fluorescein, a substance known to act on plants sometimes antagonistically to auxins.

During our investigations on the physiological activities of fluorescein dyes, we had applied a lanolin paste of 1 per cent fluorescein to stigma and cut styles of protected female flowers of cucumber. About half the treated pistils eventually developed into fruits

which answered all the descriptions of parthenocarpy, being a little smaller in size and with a relatively large fleshy pericarp and empty ovules (see accompanying photograph). Similar smaller and seedless parthenocarpic fruits have been induced in *Luffa*, egg plant and pepper in subsequent trials. Time, however, does not permit a detailed study.

It has been known that roots which have been treated with eosin, one of the fluorescein dyes, lose their geotropic sensitivity and acquire phototropism instead⁷. This action of eosin has been explained by Skoog⁸, who showed that traces of eosin cause rapid photodynamic inactivation of solutions of indole-acetic acid. When fluorescein was fed to plants at regular intervals, Sellei⁹ was able to show that fluorescein at certain concentrations (0.5-3 per cent) dwarfs the plant, but at lower concentrations (1:2,000,000) promotes its growth and general development. The concentration we used for inducing parthenocarpy far exceeds those which will have beneficial effects on plants. Fluorescein is neutral in the *Avena* test and fails to induce local swelling in decapitated epicotyls of *Vicia*, as auxins and, strangely enough, some of the very common chemicals (for example, sugar) would do. Since Muir⁶ has shown that the initiation of fruit development by pollen may be an indirect one, growth hormones being liberated from inactive combinations in the ovary after the pollen tube has been introduced, fluorescein dyes might do the same. We have in mind an analogous case in animal embryology, when certain dyes may uncover the inducing power of an embryonic tissue¹⁰. The plant used in our experiments is well known for its tendency to yield parthenocarpic fruits. It would be of great interest if similar experiments on parthenocarpy can be extended to other dyes, chemicals and even mechanical treatment.

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¹ Yasuda, *Jap. J. Genetics*, **239** (1933); **9**, 118 (1934).

² Went and Thimann, "Phytohormones" (Macmillan, 1937).

³ Gustafson, *Amer. J. Bot.*, **24**, 102 (1937); **26**, 189 (1939); *Proc. U.S. Nat. Acad. Sci.*, **22**, 628 (1936).

⁴ Wong, *Science*, **69**, 417 (1939).

⁵ Loo et al., private communication.

⁶ Muir, *Amer. J. Bot.*, **29**, 716 (1942).

⁷ Blum and Scott, *Plant Physiol.*, **8**, 525 (1933).

⁸ Skoog, *J. Cell. Comp. Physiol.*, **7**, 227 (1935).

⁹ Sellei, *Growth*, **4**, 145 (1940); **5**, 271 (1941).

¹⁰ Needham, "Biochemistry and Morphogenesis" (Cambridge, 1942).

Linear Intercepts, Areas and Volumes

IN recent correspondence, Mr. P. A. P. Moran¹ has suggested a simple method of finding the surface area of small objects from their average area of projection. Another simple method of finding the surface area and also the volume of small objects is based on the measurement of their average linear intercept (mean chord). Some years ago, while working on the determination of the grain-size of rocks, I derived two formulae and discovered two theorems related to the average linear intercepts. The formulae can be applied to the calculation of the average grain-size in granular aggregates in which the sizes and the shapes of grains are the same. The theorems, so far as I can see, have a purely academic interest, although their application to granular aggregates may be attempted.

Enlarging on the conclusions arrived at by M. W. Crofton² for convex figures, the two formulae are derived as follows: (1) In a plane convex figure (polygon, circle) the average length of projection is equal to the perimeter divided by π , and the average linear intercept (l) is equal to the area divided by the average length of projection:

$$l = \frac{\pi \times \text{area}}{\text{perimeter}}$$

(2) In a three-dimensional convex figure (polyhedron, sphere) the average area of projection is equal to the surface area divided by four, and the average linear intercept is equal to the volume divided by the average area of projection:

$$l = \frac{4 \times \text{volume}}{\text{surface area}}$$

As particular cases of these formulae we have the following theorems:

1. The average linear intercept of a convex polygon circumscribed by a circle is equal to the average linear intercept of the circle.

2. The average linear intercept of a convex polyhedron circumscribed by a sphere is equal to the average linear intercept of the sphere.

In conclusion I would like to express my thanks to Dr. H. P. Mulholland and Dr. G. R. Goldsbrough, for their help in this matter.

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¹ *Nature*, 154, 490 (1944).

² Crofton, M. W., *Proc. London Math. Soc.*, 8, 304 (1877).

Amplitude Effect in Cepheid Variables

IN the interesting review¹ of the pulsation theory in his George Darwin Lecture of 1943 before the Royal Astronomical Society, Prof. S. Rosseland has indicated the importance of unharmonic oscillations in explaining the Cepheid characteristics, and brought out the effect of the amplitude in lengthening the pulsational period, pointed out by Kluyver² in 1937, and imparting the characteristic skewness to the light and velocity curve.

In the special case, when the amplitude is of the order of a fourth of the radius, the star being composed of a homogeneous monatomic gas, on neglecting the overtone effect, and taking account of the

self-coupling term for the fundamental up to the third order only, Prof. Rosseland mentions a lengthening of period in the ratio 1.7:1, and a rise to the maximum four times faster than the decline to the minimum. While there is a considerable discrepancy to be bridged, these results should be taken as good indication of the amplitude effect.

For general values of the adiabatic index, it is, of course, imperative to take resort to approximations, even with a predominant self-coupling term; but for homogeneous monatomic gases, a complete solution for the fundamental can be obtained. One of the integrals of motion, since the time is not explicitly present in the Hamiltonian, is

$$H = K + U + V = \text{const.},$$

K , U , V being the kinetic, thermal and potential energy of the star. Neglecting the overtone velocity term in K , and the inter-coupling terms in U and V , the equation for the time coefficient can be solved without approximation, and it is found that assuming η to be the proportionate amplitude of pulsation, the time coefficient varies between the limits 1 and $(1 + 2\eta)^{1/2}$. For $\eta = 1/3$, this gives 1 and -0.6 ; the corresponding values given by the third order approximation are 1 and -0.5 . This is close enough, but at the same time the value -0.6 indicates a further increase in the discrepancy with the observed values.

The pulsational period in terms of that for the

$$\text{harmonic period is } \frac{T_{\text{anharmonic}}}{T_{\text{harmonic}}} = \frac{(1 + \eta)^3}{(1 + 2\eta)^{3/2}},$$

while the speed of increase of the velocity curve to maximum over the decline to the minimum is given by the ratio

$$\frac{\text{Time of decline}}{\text{Time of rise}} = \frac{\pi - \cos^{-1}\left(\frac{\eta}{(1+\eta)}\right) + \frac{\eta\sqrt{1+2\eta}}{(1+\eta)^2}}{\cos^{-1}\left(\frac{\eta}{(1+\eta)}\right) - \frac{\eta\sqrt{1+2\eta}}{(1+\eta)^2}}$$

These give a steady lengthening of the period from the value for the harmonic oscillation to a value 1.56 times as great. The skewness of the velocity curve increases as η varies from 0 to 1; during this time the speed ratio increases only from 1 to 4.12. For $\eta = \frac{1}{3}$ these ratios are 1.20 and 1.92, while Prof. Rosseland's values are 1.70 and 4 approximately. The details of the calculations will be given elsewhere.

Thus the fitting to the observed values achieved for the rather large value $\eta = \frac{1}{3}$ even vanishes, and the discrepancy which Prof. Rosseland rightly points out appears to be considerably greater than he thinks. For values of η of the order of the observed values, the anharmonic oscillation curves would be almost indistinguishable from the harmonic case.

We therefore think that the amplitude effect is a contributory cause to the Cepheid characteristics, and probably not a dominant cause; and factors such as the decrease in the central condensation^{3,4} must be brought in for a complete explanation of the Cepheid phenomenon.

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¹ Rosseland, S., *Mon. Not. Roy. Ast. Soc.*, 103, 233 (1943).

² Kluyver, H. A., *B.A.N.*, 7, 265 (1937).

³ Miller, J. C. P., *Mon. Not. Roy. Ast. Soc.*, 90, 59 (1929).

⁴ Kopal, Z., *Mon. Not. Roy. Ast. Soc.*, 99, 33 (1939).

ASSOCIATION OF SPECIAL LIBRARIES AND INFORMATION BUREAUX

ANNUAL CONFERENCE

THE nineteenth annual conference of the Association of Special Libraries and Information Bureaux, held in the rooms of the Royal Society on December 9 and 10, 1944, was one of the best attended conferences of the Association, and most of the sessions were characterized by animated discussions which indicated a live interest on the part of the general body of members.

In his opening presidential address, on "Organized Knowledge in the World of the Future", Sir Frederic Kenyon, after congratulating the Association on its achievements, said that the *raison d'être* of ASLIB is the service of humanity by the organized supply of knowledge. While the service of industry is its first and most obvious activity, he believes that knowledge must not be restricted to such utilitarian application but applied in the most liberal spirit to the whole of our national life. We cannot rest satisfied with the lack of appreciation of the knowledge, the skill and the inventiveness to be found in British science and scholarship and with the failure to apply them. The practical value of scientific research can no longer be denied and Sir Frederic hopes that we shall not grudge expenditure on free disinterested studies. While, however, it is right that we should try to make this knowledge readily available for those who are able to use it, that alone is not enough. Knowledge can be curse as well as blessing, and Sir Frederic urged that knowledge must be not merely organized but also its use controlled by principles of higher validity than material power. Knowledge is good, but its value is related to something higher still which Plato called the idea of good, and which Bacon called God. Sir Frederic believes that the welfare of the nation and of the world at large depends on a change of soul and a change of living, which can only be effected by a change of principle from competition to co-operation, from organization to morality or religion. The organization of knowledge must be harnessed to moral standards if strength and wisdom are to be brought together.

The first session of the Conference was devoted to a particular aspect of this co-operation, "The Empire Contribution to the Flow of World Information", and Prof R. S. Hutton presided. As a basis for discussion, members of the Conference had before them nine papers describing various specialized sources of information on and within the British Empire, those of Mr R. L. Sheppard, Mr Kenneth Binns, Mr G. B. Gresford and Mr A. L. Poole were presented in person. Some notes on the India House Library were also available at the Conference. Sir Harry Lindsay described the work of the Imperial Institute as a special library and information bureau. Sir David Chadwick outlined the work of the twelve Imperial Agricultural Bureaux. Mr Sheppard described the development and work of the Bureau of Hygiene and Tropical Diseases from the Sleeping Sickness Bureau which commenced work on June 1, 1908, in a room at the Royal Society. The Bureau is now responsible for the issue of the *Tropical Diseases Bulletin*, the *Bulletin of Hygiene* and the *Bulletin of War Medicine*, and surveys for this purpose some 650 English and foreign medical and scientific

periodicals. The abstracting is done by a pane of more than two hundred contributors specially associated with the subjects they review, and Mr Sheppard emphasized the critical character of the abstracts issued.

A note on the Library of the Royal Empire Society in 1944 was contributed by Mr Evans Lewin, who described its work more fully at the 1933 Conference. The note included a select list of periodical publications received in the Library, and a list of sources of Canadian bibliographical information was forwarded by Mr C. R. Sanderson, chief librarian of the Public Library of Toronto, among which the Canadian catalogue of books published in Canada, about Canada, as well as those written by Canadians, was singled out for mention by Prof Hutton. This has been published annually since 1923 by the Toronto Public Libraries.

The flow of information between Britain and Australia was discussed by Mr Binns, who stated that a second edition of "Pitt's Catalogue of the Scientific and Technical Periodicals in the Libraries of Australia" is in preparation, and that a similar work on the social sciences is planned by the National Library. The National Library has also issued annually, since 1936, a fairly complete list of publications appearing in the Commonwealth or touching Australia, and this, and a Select List of Representative Works dealing with Australia, issued annually since 1934, has been freely available to overseas libraries and institutions on an exchange basis. The Australian National Research Council also publishes *Australian Science Abstracts*, but in reply to a question, Mr Binns admitted that this has a very limited circulation. He also referred to the establishment this year at Australia House, London, of an Australian Library of Information as an activity of the National Library at Canberra. A further paper, "Notes on Library and Information Services in Australia", presented by Mr G. B. Gresford, emphasized the value of "Pitt's Catalogue of Scientific and Technical Periodicals in Australian Libraries", and also referred to the Scientific Liaison Bureau set up in 1942 by the Commonwealth Government and to the Information Section maintained by the Council for Scientific and Industrial Research. In concluding, he referred to the two schools of thought in Australia with regard to the publication of scientific research, and invited opinion as to the desirability or otherwise of publication in Australian periodicals or overseas. In response to this invitation, it was urged during the discussion that a policy of publication in the established British and American periodicals, such as the *Journal of the Chemical Society* and the *Journal of the American Chemical Society*, should be followed, and efforts made to avoid the multiplication of periodicals the circulation of which could only be limited.

In a further paper, Mr A. L. Poole contributed some notes on the organization of scientific research in New Zealand with a list of sources of bibliographical information on New Zealand, while the final paper in the symposium, communicated by Mr P. Freer, on "Bibliographical Work in South Africa", in addition to enumerating the chief guides to recent literature of the Union, made a number of suggestions for improvement of co-operation, some of which were taken up in the ensuing discussion. Among these suggestions were the improvement of book supply centres in South Africa, possibly inter-allied book centres in co-operation with the British Council,

co-operative cataloguing, reprinting of important books now out of print and the exchange of staff between the National Central Library and the Dominion State libraries. Very little tangible result emerged from the discussion, though there was clearly support in general for further co-operation in various directions, including abstracting, between English-speaking countries. No evidence was supplied that much progress has been made as yet on the lines indicated in the report of the British Commonwealth Science Committee, but some reference was made to Dr Needham's more recent proposals (see *Nature*, November 25, pp 649, 657).

The second session of the Conference was devoted to a paper on "Trade Catalogues in the Commercial Library", by Mr G K Wilkie, who briefly described the collection of such catalogues in the Leicester Municipal Libraries, indicating its value as a source of technical information, the way in which the collection was formed and the method of making it available to the public. He favours the vertical file system of housing, and stressed the importance of having the right person in charge of any such collection.

Past conferences of the Association have frequently suffered from the attempt to cram two papers into a session barely adequate for the discussion of one, and of this the third session was an unhappy example. Mr E Carter's able chairmanship could not avoid an untimely termination of the discussions stimulated by Mr G A Shires' paper, "The Technical Information Bulletin and what to put in it", and Mrs Moholy's report on microfilm developments. Mr Shires outlined the general policy on which the service offered was based, as shown in the issue of such a bulletin in the Dunlop Rubber Company. He aroused lively curiosity as to the means by which he secured the efficient production of abstracts from specialist members of the technical staff, but only the barest discussion of the material aspect or of the principles followed in the selection and presentation of material was possible. Mrs Lucia Moholy presented her report on "Developments and Extensions in the Uses of Microfilm". This paper covered the period since her report to the Association's Conference in November 1942. The day-to-day activities of the ASLIB microfilm service include the recording in detail of every strip of film of which a master negative is retained, catalogue entries with all available particulars which serve as a basis for the acquisition of new items, and the development of special filing arrangements. Co-operation with Government departments and special libraries has enabled the service to be extended far beyond the original scope of a technical unit. Dr Moholy visualizes two main tasks for documentary reproduction in the projects of an international clearing house of library services and for scientific co-operation: the interchange of complete books, periodicals and other publications on microfilm, and the supply of articles from periodicals, excerpts from books and other selected items for specialized research on film strips, in microprint or photostat copies as required. Documentary reproduction would be of special importance in co-operation with an international research service as a technical section covering all branches of learning—the sciences and the humanities.

An adequate supply of reading machines is still lacking, and Dr Moholy does not think that the failure to meet the demand can be justified merely by war-time difficulties. First-class microfilm readers are

still manufactured in the United States, but the supply is restricted to those who can obtain the necessary permits and high priority. Recently, a microfilm viewer has been designed in the United States for a special purpose. This reader, which was exhibited at the Conference, folds into a flat box 5 in. by 2 in. and weighs less than 2 oz. It is useful for looking up references and may in emergency serve for reading a few pages, but is not suited for research purposes. Reference was also made to the recommendations on filing and storing microfilm issued this year by the British Standards Institution (BS 1153—1944), and to the possibilities of microprint as recently emphasized by Fremont Rider in his book "The Scholar and the Future of the Research Library" (see *Nature*, November 25, p 655). Mrs Moholy pointed out that microprint is only justifiable for a considerable number of copies and is thus on an equal footing with printed matter and subject to copyright. If the technique of microprinting is adopted in Great Britain, a similar or supplementary agreement like the draft agreement on microfilm issued by the Publishers' Association in co-operation with the Society of Authors, and in consultation with the Association of Special Libraries and Information Bureaux, and published in the *Bookseller* of July 7, 1944, would be required. Mrs Moholy's report, and the subsequent discussion, indicated a more sober view of microfilm and of its limitations than formerly prevailed, and that it must be regarded as supplementary not replacing, other means, such as photostats.

The next session of the Conference, over which Mr. C le Maistre presided, considered a paper by Mr E. R. McColvin on "The Education and Status of Special Librarians", which was based on the answers to a questionnaire circulated to members of the Association, chiefly on the replies received from research organizations, industrial or commercial organizations and Government departments. Mr McColvin emphasized that organization would be better and more efficient the fewer the dead-end positions at any level to be found in it. His analysis of the requirements of both junior and senior staff led him to outline syllabuses suggested by the ASLIB Education Committee. This paper was followed by one by Miss Ruth S. Leonard on the recruitment and training of special librarians to fit the present and future needs of the special library profession in the United States. Throughout the animated discussion on these two papers, there was a pronounced cleavage of opinion, as was also evident in the voting on a resolution in favour of the question being taken up by the Association. It is difficult to see that any substantial advance has been made since the question was last debated at the Association's Conference of 1935.

At the final session, when Sir Hugh Beaver presided, Mr A B Agard Evans presented a paper on "Some Aspects of a new Technical Information Service in War-time", in which he discussed such problems against the background of the experience of the Records Section of the Research and Experiments Department of the Ministry of Home Security. This Records Section was part of the initial organization of the Department which came into being in February 1939 under the chief adviser, Dr R. E. Stradling, then director of building research under the Department of Scientific and Industrial Research. Collaboration of the records officers of the three Service departments, other Government departments and of technical institutions was secured, and the

R. P. Department and the Building Research Station in particular provided a valuable nucleus of technical information, and the Civil Defence Research Committee established in May 1939 was a further focus. Mr. Evans also referred to the generous help of the Patent Office Library, the Science Museum Library, the British Library of Political and Economic Science and the Royal Institute of British Architects on the main subjects originally covered, such as incendiary and incendiary bombs, blast, ballistics, fragmentation and penetration, building and strength of materials, were soon added others such as lighting and black-out, physiological and psychological effects, camouflage and paint, window protection, location of industry and population. In regard to shelving, Mr. Evans stated that, as in other stations of the Department of Scientific and Industrial Research, books are shelved under broad subject headings, pamphlets by country and institution, periodicals alphabetically by title. In regard to book buying, he suggested that it would be of great value to librarians if publishers would set up a joint central library of new technical books where they could be inspected with the view of purchasing through the usual channels. Mr. Evans also commented on the limitations of microfilm, and appeared to lean rather to a photostat, urging strongly the termination of the system of loaning heavy bound periodicals and substituting a photostat or microfilm copy of the title required.

STUDIES OF THE AMARYLLIDACEÆ

HERBERTIA, the year-book of the American Amaryllis Society, has now reached its tenth volume (from L. S. Hannibal, Concord, California, July 1944). This publication maintains its potent blend of science with practice. It employs fertility of number of its titles with economical expression in its individual papers, to achieve a wide review of all questions which affect the horticulture of Amaryllids. Many facets are discussed—personal, historical, and cultural. In the sections on classification, genetics, and physiology of reproduction, and pathology, several interesting facts appear.

Dr. Hamilton P. Traub, editor of *Herbertia*, has published an account of the tribe Brunsvigiææ, which, it is proposed, should now include the genera *innum*, *Brunsvigia*, *Buphone*, *Nerine*, *Ammocharis* and *Cyrtostetes*. A new genus, *Worsleya*, has been proposed to separate the single species *W. procera* from the genus *Amaryllis*, with which it has no gene change, and from which it differs in several morphological characters. The genera *Agapanthus* and *Albaghia* are border-line genera between Amaryllidaceæ and Liliaceæ, now included in the former group. J. C. Th. Uphof reviews the present position of the two genera, and describes the species included in each. As a background for taxonomic studies, J. S. Flory, jun., reports the chromosome numbers of various species of Hemerocallidææ, Alstroemeriales and Amaryllidales which have been published since his earlier review in 1937.

Gardeners and students will be interested in a brief article by Kenyon L. Reynolds outlining the method of cross-pollinating *Narcissus*. This involves the opening of pollen in a desiccator. V. T. Stoutemyer and Albert Close also discuss the latter question, suggesting the trial of freezing temperatures and finite humidities for storing pollen, and the use of

mixed pollen, hormones, and other substances for overcoming certain types of sterility. Their paper is, however, a wider review of the whole question of reproduction. Many seeds of Amaryllids germinate without a rest period, while others have a more or less protracted time of dormancy. Seeds of *Hymenocallis occidentalis* have an integument capable of photosynthesis, which appears to accelerate germination, though development can take place more slowly in the dark. It is interesting to note that vegetative propagation by scoring or cutting the base of the bulb is being employed more extensively in the Amaryllidaceæ. John V. Watkins adds a further note on the use of this method for *Lycoris aurea*.

L. S. Hannibal records the lesser bulb fly as a pest on several Amaryllids other than *Narcissus*. *Lycoris squamigera* and *Hæmanthus multiflora* appear to be even more heavily attacked than members of the genus *Narcissus*.

The natural order under discussion, however, seems to have but little acquaintance with pest or disease, and this factor should be added to that of superb garden beauty to inspire an even wider horticultural use of this interesting group.

NEW WOODS FOR CROSS-ARMS FOR TELEGRAPH LINES

AN article by G. Q. Lumsden (*Bell Lab. Rec.*, 22, No. 14, October 1944) discusses new woods for cross-arms and their preservation. Since the turn of the century, the open-wire lines of the Bell System (U.S.A.) have been carried mostly on Douglas fir and southern pine cross-arms. War emergency demands for these timbers have made it necessary, however, to seek substitutes, and the woods most readily available were red and jack pine from the Lake States and the inland type of Douglas fir from the north-west.

In testing out these alternatives it was decided to apply a preservative treatment to the new arms by an improved hot-and-cold bath process, instead of using the standard pressure processes regularly employed for southern pine arms. A solution of pentachlorophenol in petroleum was used instead of creosote for the cold bath. Pentachlorophenol is a comparatively new wood preservative, being practically soluble in water and leaving the surface of the wood clean.

About 1,100 cross-arms were treated at a time. These were laid in a tank and kept from floating by steel rails secured to the tank sides. Heavy lids were put on to hold heat, prevent excessive evaporation and keep out rain. The hot-and-cold bath non-pressure treatment was then applied. Creosote, heated to above 220° F., was pumped in to fill the tank. From two to four hours later, depending on the condition of the timber treated and the outside temperature, this creosote was pumped off. As soon as possible, and while the cross-arms were still hot, the tank was filled with a 5 per cent solution of pentachlorophenol in an aromatic petroleum at 90–125° F. After allowing another two to four hours for this solution to be absorbed, the tank was again drained and the cross-arms removed for stacking.

At the end of the cold-bath treatment, the sapwood was completely penetrated and the heartwood was penetrated around the pinholes. Retention of preservative solution varied with the amount of sapwood.

present, averaging about 8 5, 6 4, 0 6 lb. of solution per cubic foot of wood for red pine, jack pine and heartwood inland fir, respectively, in the sections between pinholes

The treated arms were stacked for curing by a method recently devised by the Bell Laboratories to keep end checking, splitting and warping to a practical minimum. They were laid on a sturdy foundation of 8 in by 8 in timbers with their ends well protected by overlapping alternate tiers. After curing, part of the arms were X-piled, to determine their tendencies, if any, to bleed, warp and split.

Breaking tests on sample arms indicated that inland fir is practically as strong as the current standard coast-type fir and southern pine arms, and that red and jack pine are about 80 per cent as strong.

Successful non-pressure treatment of red pine, jack pine and inland fir cross-arms with hot creosote, followed by cold pentachlorophenol dissolved in a suitable petroleum, opens new avenues of relief in a restricted lumber field. Other woods may be used provided they are strong enough and will take preservative treatment. For example, ponderosa pine, western hemlock and larch are all worth considering, if the supply situation warrants it. On the basis of work already done, the Bell Laboratories recommend the more promising substitute woods for cross-arms, and standard specifications have already been revised to include red pine, jack pine, lodgepole pine and inland fir.

FORTHCOMING EVENTS

Saturday, January 6

ROYAL INSTITUTION (at 21 Albemarle Street, London, W 1), at 2 30 p.m.—Sir Harold Spencer Jones, F.R.S. "Astronomy in our Daily Life", 5 "Clocks and Time Keeping" (Christmas Lectures)

Monday, January 8

FARMERS' CLUB (at the Royal Empire Society, Craven Street, Strand, London, W C 2), at 2 30 p.m.—The Rt. Hon. the Earl De La Warr "British Agriculture and World Conditions"

ROYAL GEOGRAPHICAL SOCIETY (at Kensington Gore, South Kensington, London, S W 7), at 5 p.m.—"The Burmese Scene" (Recent Kodachrome Films with Commentary by U. Myat Tun)

INSTITUTE OF FUEL (NORTH-EASTERN SECTION) (at the Central Station Hotel, Newcastle-upon-Tyne), at 5 15 p.m.—Prof. H. L. Riley, Mr. J. Blaydon and Mr. H. E. Gibson "The Molecular Nature of Cooking Coal Bitumens"

Tuesday, January 9

ROYAL INSTITUTION (at 21 Albemarle Street, London, W 1), at 2 30 p.m.—Sir Harold Spencer Jones, F.R.S. "Astronomy in our Daily Life", 6 "Finding Position at Sea and in the Air" (Christmas Lectures)

ILLUMINATING ENGINEERING SOCIETY (at the E.I.M.A. Lighting Service Bureau, 2 Savoy Hill, London, W C 2), at 5 30 p.m.—Mr. R. Gillespie Williams "The Poetry of Light"

INSTITUTE OF CIVIL ENGINEERS (ROAD ENGINEERING DIVISION) (at Great George Street, Westminster, London, S W 1), at 5 30 p.m.—Discussion on "Lay-out of Road Intersections" (to be opened by Mr. A. J. H. Clayton)

Wednesday, January 10

ROYAL SOCIETY OF ARTS (at John Adam Street, Adelphi, London, W C 2), at 1 45 p.m.—Mr. G. R. Critchley "How Wrecked and Sunken Ships are Salvaged" (Dr. Mann Juvenile Lecture)

INSTITUTE OF FUEL (at the Institution of Electrical Engineers, Savoy Place, Victoria Embankment, London, W C 2), at 2 30 p.m.—Sir Alfred Egerton, F.R.S., and Mr. Malcolm Pearce "Methane"

INSTITUTE OF PETROLEUM (at 26 Portland Place, London, W 1), at 4 30 p.m.—Dr. G. B. M. Sutherland and Dr. H. W. Thompson "Spectrographic Methods Applied to the Petroleum Industry"

Friday, January 12

INSTITUTION OF MECHANICAL ENGINEERS (in conjunction with the APPLIED MECHANICS GROUP) (at Storey's Gate, St. James's Park, London, S W 1), at 5 30 p.m.—Mr. A. Fogg "Fluid Film Lubrication of Parallel Thrust Surfaces", Dr. D. Clayton "An Exploratory Study of Oil Grooves in Plain Bearings"

NORTH-EAST COAST INSTITUTION OF ENGINEERS AND SHIPBUILDERS (in the Lecture Theatre of the Mining Institute, Newcastle-upon-Tyne), at 6 p.m.—Mr. H. O. Walker "Notes on the Buchi System"

Friday, January 12—Saturday, January 13

BRITISH ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE (DIVISION FOR SOCIAL AND INTERNATIONAL RELATIONS OF SCIENCE) (at the Royal Institution, Albemarle Street, Piccadilly, London, W 1) Conference on "The Place of Science in Industry" (to be opened by Sir Richard Gregory, Bart., F.R.S.)

APPOINTMENTS VACANT

APPLICATIONS are invited for the following appointments on before the dates mentioned

MECHANICAL ENGINEER by the Government of British Honduras for the Public Works Department—The Ministry of Labour and National Service, Central (T and S) Register, Room 5/17, Sardina Street, Kingsway, London, W C 2 (quoting Reference No. C 2408 (January 10))

LECTURER (full-time) IN THE DEPARTMENT OF CHEMISTRY—The Principal, Derby Technical College, Normanton Road, Derby (January 10)

ASSISTANT CHIEF CHEMIST (essential qualifications are supervisory and direction of Laboratory Staff engaged in investigational work and routine testing of production samples in entomological, physical and colloidal chemistry, with particular reference to detergents and emulsification) for a permanent superannuable appointment in Yorkshire—The Ministry of Labour and National Service, Central (T and S) Register, Room 5/17, Sardina Street, Kingsway, London, W C 2 (quoting Reference No. F 3039 XA) (January 10)

ASSISTANT TO THE ADVISORY OFFICER IN ANIMAL HUSBANDRY The Secretary, West of Scotland Agricultural College, 6 Blythswood Square, Glasgow (January 10)

EDUCATIONAL PSYCHOLOGIST—The Director of Education, County Offices, Oxford (January 15)

METALLURGIST (must hold a University degree in Metallurgy and be well versed in the Metallography and Heat Treatment of Al Steels and Aluminum Alloys) by progressive firm on the South Coast The Ministry of Labour and National Service, Central Register, Room 5/17, Sardina Street, Kingsway, London, W C 2 (quoting Reference No. F 2363 XA) (January 16)

RESEARCH ASSISTANT (male) in the Agricultural Entomology Division of the Ministry of Agriculture—The Assistant Secretary (Establishments), Ministry of Finance, Stormont, Belfast (January 17)

SENIOR POST as RUBBER RESEARCH CHEMIST with a large Company in the North of England engaged in rubber manufacture—The Ministry of Labour and National Service, Central (T and S) Register, Room 5/17, Sardina Street, Kingsway, London, W C 2 (quoting Reference No. F 3360 XA) (January 17)

TEACHER (full-time) OF ENGINEERING SUBJECTS for senior and junior students in the Northampton College of Technology—The Secretary for Education, Borough Education Office, Springfield, Cliftonville, Northampton (January 20)

LECTURER IN THE MECHANICAL AND CIVIL ENGINEERING DEPARTMENT of the Sunderland Technical College—The Director of Education Office, 15 John Street, Sunderland (January 20)

HEAD OF THE SCIENCE DEPARTMENT of the Blackburn Municipal Technical College—The Director of Education, Education Office, Library Street, Blackburn (January 20)

HEAD OF THE PHYSICS DEPARTMENT—The Principal, Derby Technical College, Normanton Road, Derby (January 22)

REGIUS CHAIR OF ANATOMY at Glasgow University—The Privy Secretary, Scottish Office, Fielden House, 10 Great College Street, London, S W 1 (February 24)

DIRECTOR OF MUSEUMS—The Town Clerk, Municipal Building, Dale Street, Liverpool 2 (February 28)

LABORATORY STEWARD IN THE DEPARTMENT OF PATHOLOGY—The Secretary and Registrar, The University, Bristol

DEPUTY ASSISTANT RADIUM CUSTODIAN (female) in the Radium Department—The Clerk to the Governors, St. Bartholomew's Hospital, London, E C 1

GRADUATE ASSISTANT MASTER qualified to teach MATHEMATICS and ENGINEERING DRAWING in the Junior Technical School and National Certificate Classes in the Ashton-under-Lyne Technical School—The Director of Education, 8 Warrington Street, Ashton-under-Lyne, Lancs

TEACHER OF BIOLOGY who can also offer service in CHEMISTRY and/or PHYSICS, and a TEACHER (full-time) in the MATHEMATICS and PHYSICS DEPARTMENT—The Principal, Municipal Technical College, Hopwood Lane, Halifax

REPORTS and other PUBLICATION

(not included in the monthly Books Supplement)

British Rubber Producers' Research Association. Published No. 53. Distribution of Oxygen in Oxidised Rubbers. By R. Naylor. Pp. 10. Publication No. 54. The Interaction between Rubbers and Liquids. Part 5. The Osmotic Pressures of Polymer Solutions in Mixed Solvents. Part 6. Swelling and Solubility in Mixed Liquids. By G. Gerrens. Pp. 18. (London: British Rubber Producers' Research Association.)

Hope for the North-East. Pp. 16. (Newcastle-upon-Tyne: Association of Scientific Workers.) 3d.

Catalogue

Annotated Catalogue of Works on Physics, including also Items Collateral Sciences, and comprising the Library of Prof. John Tyndall (No. 873). Pp. 88. (London: Henry Sotheran, Ltd.)

NATURE

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Editorial and Publishing Offices

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DEMobilIZATION OF UNIVERSITY STUDENTS

UP to the time of writing, no pronouncement has been made by the Government in regard to the release from the Armed Forces of university teachers, or of students to resume their interrupted studies. The national importance of dealing with this matter without delay was discussed at some length in an article in *Nature* of December 23, in which we emphasized the necessity of arriving at a satisfactory solution of the problem of the demobilization of students, and one which would ensure that the Government would not have to face misguided criticism of giving favoured treatment to a particular class of men.

The resumption by the universities of a large part of their normal activities in October 1945—if the military situation permits—is a matter of vital public interest, for there is abundant evidence of the difficulties which are likely to arise from the continued interruption of the supply of university graduates, especially in the faculties of arts and economics. The number of trained men likely to be available from these faculties, in the next few years, for the public services, for commerce, industry and for the teaching and other professions, has been reduced almost to the vanishing point. The question of the release of university teachers from temporary war-time posts in the Civil Service is already being dealt with by means of the committee appointed under the chairmanship of Lord Kennett to consider and decide applications from universities and colleges for the release of such of their staff from Government employment as they consider to be more urgently needed at the present time in their academic posts. It is to be hoped that arrangements for according a high degree of priority of release—in suitable cases—to university teachers now serving with the Forces will soon be made, for the re-staffing of the universities must obviously precede the acceptance by them of additions to the student body.

It seems to be generally agreed that in releasing students from military service, the national interest would be best served by giving the first opportunity of completing their university education to students of the highest intellectual ability. The test of intellectual ability by success in an examination is admittedly not infallible, but it is no doubt generally the case that the best and most promising men are to be found among those who have gained such awards as open scholarships or exhibitions at universities, State scholarships, or certain other scholarships awarded on a highly competitive basis. In the national interest, these are the men who should be sent back to their studies at the first opportunity, so that their services may be available to the nation in the early post-war years.

Before deciding on any scheme for the release of men for university study, its effect on the universities and colleges should be carefully considered. Many more scholarship holders go to Oxford and Cambridge than to the newer universities, and a scheme for

giving priority of release to men who have won scholarships would set free considerable numbers of students already entered at one or other of the older universities, and relatively few already accepted by the universities of the provinces. If we take the figures for recent pre-war years published in the returns from universities to the University Grants Committee, it appears that the average annual intake, by all the universities of Great Britain, of men students (exclusive of those entering faculties of medicine, which class will doubtless continue to be reserved) was in round figures about 9,000. In view of the destruction by enemy action of university and college buildings, including libraries, laboratories and hostels, and of the difficulties of getting together, in a short time, adequate and competent staffs, it seems unlikely that the universities could manage to provide in their non-medical faculties for a larger entry than 9,000 men (together with the normal proportion of women) in the initial year of peace. An estimate of the number of students who would be eligible for release, in view of their having won scholarships or other high awards in open competition, is not easy. Some will have become casualties or prisoners of war, or perhaps be unwilling to return to academic study after an interval of several years, but it seems probable that there might be about 2,000 scholars wishing to return to their studies at Oxford or Cambridge, possibly 1,000 for the colleges of London, and about another 1,000 who have gained admission and open awards to other universities of Great Britain. If these men were demobilized in time to enter their universities in October next, they would provide Oxford, Cambridge and London with about two-thirds of their normal annual entry of non-medical students, but the average entry from this source to the other universities would be only about one-fifth of the normal pre-war number. The total number so released from the Forces for university study would be about 4,000, and it is perhaps unlikely that, with all the claims which will be pressed upon the Government for Class B releases, a larger number of university students could be spared in time to enter upon university courses at the beginning of the Michaelmas term. But it is certainly desirable that the number should be sufficient to enable the provincial universities to approximate to their normal activity by starting the coming session with a reasonable number of students in each of their faculties.

If the military situation should allow of a greater total number of releases for October next than can be satisfied from the open scholarship class, it would appear to be reasonable for any margin to be filled by the release of other men who have completed part of their university course before entering on their war service, and concerning whom the universities have some information and grounds for discriminating relative merit and ability. Clearly the selection of individuals as suitable for immediately taking up their interrupted studies could best be made by the universities themselves; but the final selection from those judged to be qualified should be decided by considerations of age and length of service in each case.

In addition to the desirability of arranging that the universities should be able to open for the session 1945-46 with a reasonable number of students there is the necessity that they should be assisted to organize themselves so that, if war in the European theatre has ended, they may be ready to deal with a normal number of students in all faculties in the Michaelmas term of 1946. Most universities are only able to deal with students who join their courses at the beginning of a session, and releases for university study should be arranged so that the men will be ready to commence work by the end of the month of September. Clearly, a generous allocation of Class F releases might be made to university students in August 1945 on the ground that it would be inexpedient to make any further releases for university study until August 1946. In this respect the problem of the demobilization of students is quite different from that of arranging for the release of men who can return to civilian employment at any period of the year.

The advantages which students gain by residence in a college or university hostel during their academic courses have been strongly stressed in many quarters recently, and universities are rightly pressing upon grant-giving bodies the need for increased residential facilities. From the national point of view, the scheme of releasing from the Armed Forces and from other national service, in the first instance, those students who are in the open scholarship class, has the advantage of making use of most of the available university residences in the country, for a large proportion of the men so released would already have gained admission to one or other of the colleges at Oxford or Cambridge. But it should be stressed that the primary qualification for early demobilization would be proved ability to profit by advanced education, and the promise of becoming qualified to play an important part in the national life, not that the man would be returning to a particular university.

In considering the question of demobilization from the point of view of its effect on the universities, it must be remembered that the number of places available for men released from national service depends on the number of students allowed to enter universities direct from school, and on the number of those at present in residence to whom deferment of military service is granted. If the arrangements for granting deferment to students entering the universities in October next should prove to be less generous than those now in operation, the effect may be that, in spite of releases from national service, a considerable reduction in the total numbers of men in attendance at university courses will occur. This reduction would be most marked in those universities which have large faculties of science and engineering, and which have been assisting the national effort by concentrating on the training of technical specialists in subjects in which the acute shortage a few years ago was a hindrance to the effective prosecution of the War. It may now be right to reduce the output of trained scientific men and engineers in favour of an increased supply of specialists in other branches of university study, but the problem is complicated

is difficult, and involves a nice balancing of the probable future requirements of the nation against the military needs of the moment. The latter will undoubtedly change in the course of the year, and the best method of dealing with the matter would seem to be by keeping in being the existing joint recruiting boards at the several universities, and using them to direct the activities of all male university students, not only those of technical and scientific subjects. This would provide a ready means of adjusting periods of deferment to suit changes in the national situation. But in thus controlling the numbers admitted to university courses, and the length of course permitted in different subjects, it should be borne in mind that for the production of a trained scholar or technician, a long period of uninterrupted study is most desirable. It would appear to be in the national interest that all the more able students should now be directed to follow the full normal university courses in their subjects.

When Germany has been defeated and demobilization on a larger scale begins, the universities may find themselves flooded by applications for admission from men released in Class A, as well as those in Class B whom we have been considering. All would desire that as many men from the Forces as are suitable should be given the opportunity of further education at the university level. To provide for this it may prove to be necessary to delay the entry of young boys, direct from school, by sending them first to do a year of national service in accordance with a deliberate national policy on the lines suggested in the Norwood Report. It is certainly undesirable that such a congestion of students should occur in universities as would necessitate the continuation, even for a few years, of the inflexible organization of courses which has been necessary in many cases in dealing with the inflated numbers of students reading certain scientific subjects during the last few years.

WELSH FARMING

The Agriculture of Wales and Monmouthshire
By Prof A W Ashby and I L Evans Pp iv+300
(Cardiff Press Board of the University of Wales,
1944) 15s

IT was a very happy arrangement that Principal Ifor Evans and Prof A W Ashby should combine to prepare a book on the agriculture of Wales. They have confined themselves mainly to the period for which official statistics are available, namely, from 1867 to the present time, and Prof Ashby's wide knowledge of this branch of the subject has enabled him to avoid the pitfalls into which a less expert writer might have fallen. Ifor Evans knows the human side, and has been able to add the descriptive detail that puts life into the official figures.

The authors are fortunate in their period. In the early part, Welsh farming was mainly subsistence farming, each family ran its holding and produced the food needed; wool also was produced for clothes, and with the aid of a few craftsmen settled in the villages all the ordinary needs of life were supplied. The centres of the communal life were the

chapel and the local Eisteddfod, and there were various activities associated with these that brought the young people together. Actual cash transactions were few, limited to rent, rates, and an occasional special event, and these were met by the sale of cattle or of sheep. Petty cash for special household needs was obtainable by those near a market, but not everyone was in this position. I well remember the market at Carmarthen in 1891-92, to which the country-women came dressed in their tall-crowned hats, shawls, bodices and a bulky array of drab-coloured petticoats; they brought with them eggs, poultry and butter, the chief characteristic of which was its great variation in quality, no two samples ever being alike, but all being poor. The pitiful thing, however, was the low level of prices, for there was no organized marketing and the sellers did not wish to take their produce home unsold. It was a peasant community, and its problems could find a parallel in any of the peasant countries of Europe.

Then came the great change. From the early days of this century the subsistence farming gave place to farming for the great markets of England and South Wales. Things were produced for sale, and not for home consumption; the people ceased to be peasants and became small farmers. The change took a long while, indeed the authors do not think it was complete until 1939. They trace in great detail the changes involved. Livestock and livestock products became more important and arable crops less; the reduction in these, especially grain, is very graphically shown. Unfortunately, the change was accompanied by a general abandonment of liming, which had previously been common, the early agricultural advisers were not blameless here, for they too often thought that the basic slag they were busy introducing could take the place of lime.

Once Welsh agriculture was fairly on the sales basis, its history was not unlike that of English farming; it was subject to the same economic factors, enjoyed temporary prosperity during the two Wars and suffered from the severe slump that came in between. The livestock figure for 1916 marks a record high level which was only just passed in 1937, while that for 1920 is the lowest in the present century. But the authors are careful to note and explain the differences between Welsh and British farming, which are numerous.

The Welsh farm still remains essentially a family affair; farmers and their relatives accounted for more than 60 per cent of those engaged in agriculture in the last census (1931). Even so the number of 'male relatives' working on the farms decreases, and the staff tends to reduce itself to the farmer, his wife and his children. One difference from English practice is brought out: when the parents die, the inheritance is divided equally among all the children, whoever takes the farm has to buy out his brothers and sisters, and this may land him in debt, with awkward consequences. Yet the system works, for in a sample survey, 75 per cent of the farmers were sons of farmers, while only 11 per cent were sons of farm workers and 7½ per cent sons of other manual workers.

The authors state, with some reserve, that nearly half the arable land and pasture of Wales was in 1931 in farms of 50-150 acres, and less than one quarter in farms of 150 acres and more. These two groups of farms employed less than one half the total number of full-time farmers.

Livestock, especially milch cattle, are now the central feature of the farming, and this has empha-

sized the need for improving the grassland. There is a steady rise in the proportion of cows and heifers, and a fall in that of older cattle for meat production. This has of course led to a marked increase in milk production.

So far as actual numbers go, sheep are the most important element in Welsh live-stock, and, as for cattle, the number was lowest in 1920 and highest in 1939. As in England, however, a diminishing number live more than one year, the taste for fat mutton having gone, most are killed or sold as lambs, and only the breeding ewes are kept. The lowland farmers have devoted much attention to the production of early lambs.

Pigs have always furnished much of the meat of rural Wales, but they too now enter into commerce especially for bacon production.

The change-over from subsistence farming to farming for the market meant of course that the farmers became liable to all the risks of competition from outside, to the vagaries of prices which lay right beyond their control, and to other troubles. On the other hand, the young people prefer the new life, and however much on sentimental grounds one may regret the passing of the old, one must admit it had many bad features. Farmers now have more scope than in the old days, they can benefit by organization—by co-operation and better marketing. They can take fuller advantage of agricultural education and research, and make better use of improved methods and appliances than was formerly possible. Co-operation has not developed as much as it might, 'societies' supplying requisites have proved more popular than those dealing with produce. Welsh farmers, however, have always been keen on education: indeed, the College at Aberystwyth is in part a tribute to their interest. The Welsh farms and villages have always supplied a high proportion of excellent students. It is therefore all the more surprising to read that agricultural education and advice, as organized by the Welsh counties in the 1930's, did not exercise any noticeable influence on more than 20–33 per cent of the agricultural population.

The volume is so well documented that the appendixes extend to well over one hundred pages while the text covers one hundred and seventy pages. But these appendixes are full of valuable information not easily obtainable elsewhere, and they include an extensive set of statistics with annotations, for all of which students will be deeply grateful.

The authors have accomplished with great distinction a difficult task and they have set a standard to which other writers on the agriculture of a region will do well to aspire.

One good book always evokes the desire for another. Would it be possible for the Honorable Society of Cymmrodorion and the Press Board of the University of Wales, which have produced this book so well, to give us a history of Welsh agriculture going back to the most ancient times? Early records may be scanty, yet the National Library has a big collection of manuscripts from which something might be gleaned. One would expect the earliest agriculture to have some relation to the early farming on the open lands of the south of England but had it? In any event, where did the old varieties of cereals come from—Hen Gymro, Ceirch Llwyd, Ceirch du bach, Haidd Garw, and others? They certainly were not indigenous, nor were the old Welsh animals.

E. JOHN RUSSELL

THE INTERNATIONAL PETROLEUM POSITION

Peace, Plenty and Petroleum

By Benjamin T. Brooks (Science for War and Peace Series) Pp. vi+197 (Lancaster, Pa. Jaqu Cattell Press, 1944) 2.50 dollars

THIS review of the present position of the American petroleum industry may not prove particularly palatable to those nurtured on the pleasant theory that undiscovered reserves in the United States amount to "some comfortable astronomical figure", to quote the author's own words. Indeed, it will be a hard task for a nation which has for many years produced 65 per cent of the world oil to adjust its independent viewpoint and face the fact that its domestic production is no longer adequate to its own needs. America has become an oil-importing country, and if present trends within the industry continue, she will become increasingly dependent on foreign supplies.

Furthermore, the author is of opinion that even with the cessation of hostilities, shortage of crude oil will persist. Petroleum is the basic essential of a form of modern warfare, without it, navy, air force and army would be immobilized. Production has, however, been pushed to an artificial peak to supply the amount of fuel sought by the U.S. Petroleum Administration for War, but the record figure of 4,200,000 barrels a day attained in the summer of 1943 cannot be maintained indefinitely. The yield of a majority of fields has been increased beyond the optimum economic rate of flow, and estimated reserves have correspondingly diminished. Recent decline in the rate of discovery of new resources aggravates the seriousness of the position, particularly when it is apparent that exploration activity has not shown a parallel decline. Figures published by Mr. E. L. De Goyer, deputy administrator of the Petroleum Administration for War, show that in 1937, when the discovery-rate first showed a decline, 2,224 wild-cat wells were drilled, while in 1943, 3,045 wild-cat wells were drilled.

It is not thought likely that shortages of crude oil in the United States will be met for some time by the manufacture of substitutes. Only where price-levels of crude petroleum, and its products are substantially higher than at present will it be commercially feasible to produce fuels in quantity from shale oil, coal, water gas or alcohol, and in any event manufacture of such substitutes on the scale required could scarcely be improvised in war-time. Immense new fields have been discovered and developed in other countries, particularly during the past few years, and it seems reasonable to suppose that domestic shortages in the United States will be made up by importations from Venezuela, Colombia, Mexico, and possibly from Saudi Arabia, Iran, Iraq and the U.S.S.R. Thus the success of American oil companies operating abroad has become a matter of national importance, and, according to the author, "it is not too much to say that the much derided dollar diplomacy has come back into our [U.S.] State Department with some new improvements."

The book is, by design, thought-provoking and challenging. At a time when a series of international conferences regarding the world's oil is envisaged and when the United States is beginning to plan a foreign oil policy, the author feels that the public is entitled to know the full story of the petroleum industry.

Under various chapter headings he reviews economic problems concerning oil in world politics, difficulties and hazards of foreign oil production and the part which oil seems destined to play in the post-war world. In addition, there are formative chapters on petroleum substitutes, the geographical distribution of oil, chemistry of petroleum and the growth of the petroleum industry.

Mr B T Brooks is well qualified to write a book of this character, having had thirty-two years experience in the petroleum industry. The book is written primarily for the American public, but there are many in Great Britain who will find it interesting, and indeed it is highly desirable that problems facing the American petroleum industry should be fully understood here. There is no doubt that as 'co-reporters' of foreign oil, Great Britain and the United States will have many problems to face before international agreement is reached on the best method of exploiting world resources of petroleum. The author suggests that "international co-operation after the war will evidently involve a world rationing of such things as petroleum, with quotas, at least to certain nations. International agreements regarding oil means Britain and the United States, and possibly Russia, and this in turn means that private companies must operate within the framework of such government agreements. It means a kind of worldwide oil cartel, with the blessing of our own and other governments, although with the foreign policy makers laying down the rules."

A CRITIQUE OF PASTEURIZATION

The Case Against Pasteurization of Milk

Statistical Examination of the Claim that Pasteurization of Milk Saves Lives. By John P Bibby. Pp 71 (London: Staples and Staples, Ltd., 1944). 6d net.

THE three main theses of this booklet (written as a critique of Prof G S Wilson's book "The Pasteurization of Milk") appear to be (1) that exposure to light infection by active tubercle organisms is the best way to induce human resistance to tuberculosis, (2) that the regular consumption of raw milk infected with bovine tuberculosis is a feasible way of developing such resistance, and that the counter with infective material should take place at an early age—in short, that the consumption of tubercle-infected milk by young children is to their ultimate benefit, (3) that pasteurization not only does us the disservice of preventing this "exposure to light infection" but also seriously damages the milk nutritionally, "devitalizing it at source", an impairment that, it is stated, can be to some extent corrected by adding vitamin D to the diet.

No one would contest Mr Bibby's view that serious tuberculosis in man should be combated in every possible way, but the logical corollary to his theses (1) and (2) is that the owners of tuberculin-tested herds who at present receive 4d premium for each gallon of milk produced should be penalized and not rewarded. The premium should, presumably, be paid for milk 'lightly infected' with *M. tuberculosis* cows with tuberculous udders—doubtless not too severely infected—would appear to be a national asset as an insurance against human tuberculosis. All more should this apply to the lactating tubercul-

ous woman, one wonders whether Mr. Bibby would knowingly put a young child of his own to the breast of a tuberculous wet-nurse?

But even if it were possible to effect satisfactory immunization against tuberculosis by the oral route—a dubious assumption—medical and public opinion would insist that the method should be controlled. Definite numbers of organisms of standard virulence would have to be used, and if the milk to be given to young infants were to be thus artificially infected, it would have to be free from the risk of producing other diseases at the same time, that is, it would have to be previously pasteurized or from absolutely disease-free herds. Moreover, if individual immunity could be acquired in this way, it would have to be acquired in each generation—a grim prospect.

One comment on thesis (3) is not unfair. If the nutritional case against pasteurization has to depend on the selection of statements from early experimenters whose work has not stood up to modern re-investigation, then it is poor indeed. In discussing the effect of pasteurization on the nutritive value of milk, the author quotes nothing later than 1931; this is not done in ignorance, for much of the more recent work, which uniformly does not support this thesis, is quoted in Prof Wilson's book.

H. D. KAY

VIRUS DISEASES

Virus Diseases in Man, Animal and Plant

By Gustav Seiffert. Translated by Dr Marion Lee Taylor. Pp ix+332 (New York: Philosophical Library, Inc., 1944). 5 dollars.

THIS edition of Seiffert's work is a translation by Marion Lee Taylor. The book is divided into five main sections. Section A is a 'General Division' in which the main properties of viruses are discussed; Section B gives a brief review of "Certain and Questionable Virus Diseases of Man, Mammals and Birds"; Section C deals with virus-like organisms such as the Rickettsiae, bacteriophages, *Bartonella* and the agents of pleuropneumonia and agalactia; Section D is concerned with filtrable bacterial forms, and in Section E a short and incomplete description of the laboratory methods of virus investigation is given. In view of the wide scope of the book, it is possible in the space allotted to consider only the superficial aspects of the different subjects under review.

The original German version was undoubtedly a useful contribution to the literature on viruses, and probably fulfilled the aim indicated in the preface, namely, "to furnish an introduction for the many who wish to occupy themselves more closely with the virus problem, to make possible by references to literature further penetration into the subject . . ." This present edition is, however, unlikely to serve any useful function. It is an almost literal translation from the German by someone who does not appear to be particularly conversant with either the viruses or the virus-diseases. In consequence, the texture is difficult to follow owing to the close adherence to the original German construction, and many terms, unfamiliar to the British bacteriologist, have been included. Furthermore, although numerous references to original papers are given, all concern articles written prior to 1938. There has been no attempt to bring the edition up to date. R. W. F.

THE GAS INDUSTRY: YESTERDAY AND TO-MORROW*

By DR. E. F. ARMSTRONG, F.R.S

History of Gas Lighting

AS a provider of one of the four basic necessities of life (food, shelter, clothing and warmth), gas is a leader among British industries. It carbonizes annually 20 million tons of coal, making more than 1,700 million therms of gas. It is the nation's third biggest ratepayer, one of its largest employers of capital (£200 million), its seventh largest direct employer of labour.

It is a hundred and fifty years since William Murdoch in 1792 first lighted up his house at Redruth with gas generated from coal in an iron retort in his back yard. He also had a gas lantern constructed, with the jet attached to the bottom of the lantern and a bladder of gas underneath, with which he lighted himself home at night across the moors when returning from his work to his house at Redruth. Many years later (in 1818), when Murdoch was at Manchester for the purpose of starting one of Boulton and Watt's engines, he was invited, with Mr. William Fairbairn, to dine at Medlock Bank, then at some distance from the lighted part of the town. "It was a dark winter's night," wrote Mr. Fairbairn, "and how to reach the house over such bad roads was a question not easily solved. Mr. Murdoch, however, fruitful in resources, went to the gasworks (then established in Manchester), where he filled a bladder which he had with him, and, placing it under his arm like a bagpipe, he discharged through the stem of an old tobacco pipe a stream of gas which enabled us to walk in safety to Medlock Bank."

Murdoch was followed by Samuel Clegg, who installed gas in factories and other buildings and produced many inventions calculated to make its use practicable. Together with F. A. Winsor, his efforts led to the foundation of the first gas company, the Gas Light and Coke Company, which to-day is still the largest in the world. Gas became the fashion, and by 1829 there were already some two hundred large and small companies.

Lighting was its primary function in those days—what a boon it must have been. It made street lighting possible and did much to put down crime. At first the extremities of pipes had small apertures, later came the batwing and fishtail burners, followed in 1850 by the Argand burner with an air regulator. Suggs' invention of the governor, a pressure-controlling device, nearly doubled the light given by the street lamps.

Just a century after Murdoch's start, gas lighting was given new vigour by the discovery of the incandescent gas mantle, which made use for the first time of the heating and not of the illuminating ingredients of gas. This discovery came just as the new electric light was becoming a competitor. I well remember as a boy my father telling us at breakfast of a dinner party at Joseph Swann's the previous night in his dining-room lighted by electricity, the first to be so equipped.

I must resist the temptation to trace the historic development, allowing myself only one incident which refers to the Royal Institution. In 1818 a committee was appointed "to take into consideration the expediency of lighting the Institution with gas instead

of oil." Those were leisurely days and nothing appears to have been done until 1828, when another committee was appointed which "recommended the use of Portable Gas for lighting the library and lecture theatre on Friday evening meetings." This supply lasted until 1834, when the Portable Gas Company went out of business. Coal gas from the street main was substituted. But this bare statement hides Faraday's personal contact with the Portable Gas Company, no doubt at the time of the first committee. It was in the gas provided by the Portable Gas Company that he discovered benzene in 1825. It was not twenty years later that its presence in coal tar was proved. So the attempts of the Royal Institution to be up to date and use gas to light its rooms were responsible for one of the greatest discoveries in organic chemistry.

Prior to the advent of the incandescent mantle, it was the 'illuminating' ingredients of gas that mattered, and the strict supervision of quality carried on in accordance with the City of London Gas Act. 1868 expressed this illuminating value in terms of standard candles. When heating became the criterion of quality, these illuminating constituents ceased to be of importance, and in 1904 a Board of Trade Committee recognized the calorific value of gas, though it was not until 1920 that the change from an illuminating to a calorific value standard was made law. Gas was henceforth charged for not by volume but by calorific value expressed in therms.

By this time technical development both in the refractory materials used to construct the retort and in the art and practice of carbonization made possible to use higher temperatures so as to obtain greater yield of gas per ton of coal. This is still the goal of every gas engineer. Such gas has calorific value, but has largely lost its illuminants. The change therefore, encouraged good technical practice and opened the way to the modern use of gas as heating agent.

But before I leave lighting I must make some reference to street lighting, because this is a field in which gas still holds its own. For internal lighting the convenience of the switch and considerations of decoration have enabled electricity largely to replace gas even at the expense of the quality of the light and its effect on eyestrain. Some of the best street lighting in London before the 'blackout' was by gas burned in high-pressure incandescent lamps. A convenient comparison, which shows the advance made in terms of candle-power per cubic foot of gas consumed per hour. In 1899, using flat-flame burners, this was 2.5, the substitution of mantles in 1900 made it 14, a figure increased to 19 when the mantles were inverted in 1913, finally, in 1931, high-pressure lamps brought the figure up to 42.5. The lamps at Whitehall gave an illumination of 2,500 candles in direction at right angles to the surface of the mantle.

Manufacture of Gas

I myself think of the gas industry in two parts, one, the manufacture of gas and the technical side and future developments associated with it, and the other, the distribution of the gas, its burning in suitable appliances and the service given to the consumer.

The making of gas is a highly specialized and skilled operation, especially in a large gas works. There has been continuous progress, and although to-day the thermal efficiency of gas-making is 80 per cent, the gas engineer has never been more active in seeking

*Royal Institution discourse delivered on November 24

new means of advance for the future. The two main considerations at the moment are the lowest possible price for gas and the maximum economy in the use of coal. One approach is completely to gasify coal, that is, to make coke for sale. Many undertakings turn part of their coke by treatment with steam into water gas. This is a convenient way of adding to the make of gas at the time of peak loads. An alternative involves a pressure process of gas-making, the coal being carbonized in presence of hydrogen. The process takes place in two stages, the first forming a gas rich in methane together with a primary tar and some carbonaceous residue. This residue is fed to a producer operating under pressure and supplied with oxygen and steam in which the hydrogen requisite for the first operation is produced. There is a possibility, according to Dr E. V. Evans, of producing from 1 ton of any coal—value 300 therms—some 210 therms of gas, together with a tar which can be hydrogenated to petroleum products and also compressed hydrogen. This possibility—the making of methane from coal—is being followed up with the full energy of the Gas Research Board.

Yet another process under study by the Board involves the production of methane catalytically at low pressures. Success in this process would replace some of the gas oil required when water gas is manufactured, and give some control over coke production, but it would not enable the use on gas works of any kind of coal.

A suggestion is to gasify the coal underground, as is said to be done in the U.S.S.R. There is little information available, and no evidence that this process is a success or that it is applicable to British conditions. It has been tried with poor seams, probably uneconomical to work as coal, and gives a gas of low calorific value.

Much can be done by selecting those seams of coal most suited for gas-making. The Fuel Research Board is making a careful survey of the coal of Great Britain, having regard to its suitability for particular purposes. The best form of fuel economy is to use each type of coal where it gives the best results. Unfortunately, such ideas do not commend themselves to the officials who now control these matters to whom coal is coal.

The making of gas resolves itself into the devising of plant in which, during the treatment of coal by heat, the conditions of cracking are such that satisfactory yields of the desired products are obtained.

Coal is a complex hydrocarbon of definite molecular structure, when it is carbonized, nascent hydrocarbon oils are distilled from it which are then decomposed and hydrogenated. The chemist has sought to gain an accurate picture of what is taking place in the retort, so that the engineer may apply this knowledge to practice and obtain the maximum number of therms from a ton of coal—which is to-day about 75. Such factors as the size of the charge of coal into the retort, rapid or slow carbonization and very many technical considerations have all been studied. One of the main objects is to avoid cracking the volatile products and so producing more than a minimum of free carbon. Such studies have also to include the physical characteristics of various coals.

I have alluded to this work so as to make it clear that carbonizing coal is not a rule of thumb operation, but one based on much scientific study, of which the principles are now well understood.

Carbonizing in all its branches is a continuous struggle on the part of the maker of refractories to

provide bricks and retorts which will have a long life at high temperatures so as to meet the demands of the users. Much research is going on in this direction.

Distribution of Gas

Now a word on the distribution side, for it is an important and costly item in the supply of gas to every home. The providing, laying and servicing of gas mains is a highly developed technique. Obviously the more customers which can be supplied per mile of main the better, ribbon development, with supply to scattered customers, is more costly. There is a limit to the distance to which a gas main can be carried economically without a substantial user of the gas en route. This has brought up the question of the co-ordination and grouping of separately controlled units, each working in a restricted area, into larger centralized companies linked up to ring-main distribution systems giving a supply of constant quality, purity and pressure. The gas engineer is fully alive to the importance of these three criteria, and although perhaps he has sometimes been at fault in the past, in this respect he will not be found so in the future.

The householder, however, is not interested in gas until she begins to use it. For this purpose appliances are required, appliances which are becoming more complex and more costly and therefore impossible for the ordinary consumer to buy. Hence the development of hire purchase and simple hire systems by the gas undertaking, and the servicing of these so that they are in perfect order. To obtain regulated heat to-day for cooking, space heating, water heating or other purposes, nothing more is required than to turn on a tap and light the gas with a match or other means. The consumer saves all his own personal labour and trouble, he has to keep no stocks in his coal cellar. The undertaking supplies serviced heat, and this is what is really being paid for. Comparisons of the cost of coal and gas per therm have no meaning whatsoever. Coal has to be carried, the ashes removed, the dirt cleaned and the purchase financed months in advance of use. It is this service which is to-day, and still more to-morrow, the function of the gas industry. New and more economical forms of appliances are being devised, and they have to be decorative as well as efficient—not always the most easy combination. The useful geyser has been replaced by the instantaneous water heater, the modern cooker is a triumph of labour-saving and efficiency, the gas fire has all the virtues except that of portability.

It is not my task to explain modern gas appliances, but I do want to direct attention to the latest development of heating by the non-aerated-gas type of burner sometimes called luminous heating.

Before the War, only some gas undertakings extracted the benzol from coal. It is now compulsory. Gas no longer therefore contains any constituent that burns with a smoky flame, and hence 'excess' air mixed with the gas in the burner is not required to burn it. Enough air is drawn into the flame at the aperture to burn the gas completely. Such flames are silent in operation, they are not cooled by excess air and have many advantages both in cookers and gas fires. Other advantages are immunity from back lighting, less choking of jets by dust and less need for maintenance attention. This type of heating marks definite progress.

Gas Tariffs

The method of charging for gas is one of moment to both supplier and consumer. To-day gas is measured

by meter, and the quantity used is charged for on the basis of its calorific value, that is, by the therm. Gas is essentially the poor man's fuel, and the prepayment meter has made it easy for him to obtain it in small amounts as desired for cash. Larger consumers have their meters read quarterly and have that amount of credit.

Actually a far more satisfactory method of charge capable of leading to progressive development would be similar to that adopted for the telephone and by the electrical industry. In both these there is recognition of the service rendered by having the commodity on tap—a fixed annual charge covers the overhead charge of the service and enables the commodity charge to be low. This would mean that extra use of gas above a minimum becomes cheap and therefore attractive. As it is, most of the small users of gas are unremunerative to the industry. An attempt to alter this state of things in London met with considerable opposition probably because the ground was not sufficiently prepared for its wisdom to be understood. Dr E. V. Evans, the acknowledged technical leader of the gas industry, outlined a little more than a year ago an ideal scheme for a unit community involving the co-operation of the two services gas and electricity, for the development of an ideal balanced fuel-supply. It incorporated a fixed charge for the ordinary dwelling house of 40s per annum and a supply of gas at 6d for the first 300 therms and 4d a therm afterwards. The charge to the domestic consumer must include payment for the services given him, whereas the charge to industry is for a convenient heating material in bulk and does not include services. It can be directly related to the cost of coal.

The Relationship of the Gas and Chemical Industries

A problem of interest for the future is the position of the gas industry as a source of raw materials for the chemical industry, in particular the new synthetic chemical industry from which so much is hoped in the days to come. In the past, much of the organic chemical industry has been built up on tar products—notably benzene, toluene and naphthalene, but the demands of chemists have only taken a little of the tar made, so that other uses have had to be found for the bulk of it. This problem has been largely solved by the use of tar on the roads—not haphazard, but in the form of tar carpets scientifically designed.

The motorist has taken the surplus benzol at a price which includes the tax on imported petrol; this demand is resulting in all the benzol being scrubbed out of gas. This can only take place if the price paid for it represents the value of the benzol as therms in the gas and the cost of separating it. The chemical industry wants cheap benzol and is reluctant to pay the equivalent of the hydrocarbon duty on it.

Gas also contains ethylene, while its main constituent is methane. Are these worth more to chemical industry than to gas as therms? Since Great Britain has only a very small oil-refining industry, it largely lacks the two carbon compounds from which most organic syntheses start. The problem is, Shall the gas industry concern itself only with its legitimate business, the making and distribution of gas, or shall it be in with the synthetic chemical industry and help to make basic raw materials for it? Only the future can answer. Personally, I hold the view that a gas works should be the place in which all coal should be processed, some to make gas for the

domestic consumer and for industry, some to make methane, benzol, and other raw materials for chemical industry, and some to make petroleum hydrocarbon. The balanced interlocking of the various processes would lead both to economies in the use of coal, almost Britain's only raw material with a thermal value, and bring about a cheapening of the various products enumerated. Vision for the future is required, but at a moment when an influential Government committee is inquiring into the future of the industry, its potentialities as a scientific coal-processing industry should be given full consideration.

SEED-BORNE FUNGI

ON October 28 the British Mycological Society met in Birmingham to discuss certain seed-borne fungal diseases. The programme was arranged by the Plant Pathology Committee of the Society.

The first two papers dealt with fungi parasitizing the seeds of British grasses, and Dr Mary Noble, in an interesting account of the blind seed disease of ryegrass, directed attention to its effect in reducing the germination of seeds, especially those of the modern 'leafy' or 'indigenous' strains. Since these leafy strains normally seed much less profusely than the commercial types, this added loss is especially serious. The disease is known in New Zealand, where it has caused considerable damage in some recent seasons, and is now widespread in Britain.

The identity of the causal fungus has been the subject of much confusion. The imperfect stage was first erroneously ascribed to *Pullularia*, while the perfect stage was originally described as an amoperculat discomycete of the *Helotia*, but the close similarity of the blind seed fungus to the rye parasite *Phiale temulenta* of Prillieux and Delacroix was observed by Dr Noble and her colleagues at Edinburgh. Subsequent investigation of the anatomy of the apothecium supported the view that the two fungi were identical, and this was finally proved by Dr Neill in New Zealand, who examined some of the original material of Prillieux and Delacroix. In addition to rye and *Lolium* spp., *P. temulenta* has been found infecting *Festuca arundinacea*, *F. rubra* var. *fallax*, *Cynosurus cristatus* and other grasses, but its commercial importance so far is confined to the ryegrasses. Infection occurs at flowering time, that is, in late June in Great Britain, at a point on the ovary just below the stigma. Large numbers of conidia are produced externally, but hyphae penetrate more deeply and may completely destroy the embryonic structure. Blind seeds result from rather late infection after the embryonic tissues and the endosperm have been differentiated. Still later infection may result in the production of conidia, but the embryo escapes and the seeds remain viable. Blind seeds are sown with healthy ones, and, provided they are not more than 1½ inches under the soil, give rise to stalked apothecia just as the ryegrass is coming into flower. The production of apothecia continues for about three weeks, and thus both early and late strains of ryegrass are subject to infection. Cool weather favours infection, as under these conditions the dissemination of pollen is reduced while the glumes open repeatedly and entrance of the fungus is facilitated.

Since *Phiale temulenta* penetrates so deeply into the seed the disease cannot be controlled by fungicidal dusts, and the only practical way of cleaning large

stocks of seed is to store them for two years, during which time the fungus dies out. In Scotland in 1944 a trial service was set up along the lines of one already functioning in New Zealand, under which growers were invited to send in samples of heads before harvest. These were examined for the disease and a reply sent to the grower within two days advising him as to whether his crop was worth saving for seed or not. This is a great help, as it saves the useless work of harvesting diseased seed, and the crop can be converted into hay.

Single-spore (ascospores or macroconidia) isolations of *P. temulenta* give cultures of two types (a) mainly conidial with a smooth shiny type of growth, or (b) mycelial in which the surface of the colony is rough, due to the development of white aerial hyphae. It is just possible that this mycelial form may be the well-known *Lolium* endophyte, but so far no proof has been obtained that the blind seed fungus can infect its host systemically. The various endophytes of *Lolium* were discussed by Miss K. Sampson in her paper on "Some Endophytic Fungi of the Grasses". Darnel (*Lolium temulentum*) has long been known to carry an endophytic fungus situated just outside the aleurone cells of the seed, and *Lolium remotum* and *L. multiflorum* also have endophytes which appear to be of a similar nature. In *L. perenne* two types are distinguished. The first occurs in indigenous perennial ryegrass in Great Britain but not by any means in every plant. It was isolated and cultured at Aberystwyth in 1937, and Neill (1941) in New Zealand, by different methods, also cultured a fungus which appears to be identical. Neill observed sporodochia and microconidia very similar to those produced by the blind seed fungus. This again suggests the interesting possibility that this *Lolium* endophyte may be a non-fertile strain of *Phaelia temulenta*, but there is still the difficulty that nobody has yet shown that the blind seed fungus can cause systemic infection in *Lolium*. The second *L. perenne* endophyte has only been studied at Aberystwyth, and is distinguishable from the first by its mycelial characters and by the comparative ease with which it can be cultured. Its microconidia seem more characteristic of *Sclerotinia* than of the *Endoconidium* type figured by Neill for the first *L. perenne* fungus. It seems that we still need to clear up many points in relation to the fungi parasitizing *Lolium* spp., but the information given by Dr. Noble and Miss Sampson at this meeting suggests that appreciable progress has been made in this direction. The choke disease of grasses caused by *Epichloe typhina* was also mentioned by Miss Sampson. We know that the disease is carried by the seed in certain species, notably *Festuca rubra* and *F. ovina*, but so far it has never been demonstrated in the seed of cocksfoot (*Dactylis glomerata*), one of the most seriously affected grasses in Great Britain.

Dr. Millard gave an interesting account of broccol canker (caused by *Phoma lingam*) in the West Riding of Yorkshire, where many small growers save their own seed and therefore run into trouble since the disease is seed-borne. These local strains have become infected, but they are suited to the district, and growers are loth to import recognized varieties from other parts of the country which often do not acquit themselves so well in Yorkshire. In order to clean up these local strains, Dr. Millard for some years has accepted from growers seed stocks which are freed from *Phoma* by immersing them for twenty-five minutes in a hot water bath at 50° C. Germination may be depressed a little but in practice this has not

proved serious unless the seed was old. Stocks have been cleaned and propagated at Askham Bryan and handed back to the growers in a perfectly clean condition. The value of this service to the market gardener needs no emphasis.

A case of seed-borne club root (*Plasmodiophora Brassicae*) on swedes was described by Dr. L. G. G. Warne, of Manchester. Dr. Warne was able to infect a clean sample of seed with washings from an infected one, a thing which has not been done before. We do not know how widespread seed-borne club root is and it probably does not occur very often, but the fact that the possibility has been demonstrated is of great interest to plant pathologists and gardeners generally.

An account of seed examination at the Pathology Laboratory of the Ministry of Agriculture and Fisheries, Harpenden, was given by Dr. A. Smith, who explained that practically all the samples are from consignments intended for export to countries requiring a certificate of health based on an examination of the seeds.

More than four thousand samples were examined in the year covering 1939-40, the great majority being vegetable and flower seeds. The War has cut down this export considerably and few agricultural seeds are exported to countries requiring certificates. The main causes of rejection are *Ascochyta* in peas, *Septoria* in celery and parsley, and halo blight in dwarf beans, but occasional samples of other diseased seeds are encountered. The presence of *Ascochyta* in seed peas was responsible for the rejection of 23 per cent of all peas examined for export purposes between 1925 and 1943. Considerable rejections of peas for marsh spot have also occurred, but, since it has been realized that this is not a communicable disease, affected peas may be exported provided they are likely to give a sound plant. In the same period 23 per cent of all samples of celery seed have been refused certificates because of the presence of *Septoria* pycnidia on the seed. An even greater percentage of parsley has been so rejected, namely, 31 per cent. Comparative figures for halo blight (*Pseudomonas phaseolicola*) are not available, but in recent years the percentages rejected have varied from 5 per cent to, in one year, as much as 25 per cent of the samples submitted.

All seed-borne diseases are not recognizable from an examination of the seeds themselves nor can they all be detected on incubation. Some diseases, for example, certain bacterial and virus diseases, as well as certain downy mildews in the seed coat, must perforce escape detection. Freedom from these can only be assured by an inspection of the growing crops.

Among seeds examined for purposes other than export may be mentioned a sample of onion seed which showed the presence of *Botrytis Allii* as a seed-borne disease.

G. C. Ainsworth exhibited maps showing the world distribution of certain seed-borne fungi from the series of "Distribution Maps of Plant Diseases" now being issued by the Imperial Mycological Institute. He emphasized that seed-borne diseases are often a particularly suitable subject for legislation, and this aspect was briefly discussed in connexion with fungi the range of which is, or is not yet, co-extensive with that of the host.

The importance of seed-borne diseases was stressed in an interesting discussion that followed the papers, and the meeting certainly proved successful in providing an opportunity for useful comment on this very topical problem.

J. H. WESTERN

IMPORTANCE OF POTATO VIRUS X IN THE GROWING OF POTATOES

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AND

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VIRUS diseases are estimated to cause a loss in Great Britain of one million tons of potatoes a year, and this in spite of the importation of large quantities of seed potatoes, for example, last autumn and winter the Government imported 400,000 tons of seed potatoes from Scotland and Ireland.

There are three potato viruses which are of importance from the grower's point of view, they cause leaf-roll, severe and mild mosaic respectively. The first two diseases are aphid-transmitted and are infrequent in the best seed-growing areas of Scotland, where the aphid vector is uncommon. When these diseases do appear, they are easily visible and can be eliminated by careful roguing. With regard to virus X, which gives rise to mild mosaic, the situation is different. This virus, which occurs in strains of varying virulence, is present in a very high proportion of the best Scotch seed potatoes, not excluding those with a Stock Seed certificate. It is indeed scarcely an exaggeration to say that all the Scotch stocks of Kerr's Pink are infected with virus X. With the exception of a few varieties of potatoes, notably King Edward and Epicure, together with one or two others of less commercial importance, which react with a necrotic disease (top necrosis), the disease caused by virus X is extremely mild and often consists only of a faint and transitory mottling of the leaves. It is impossible, therefore, to say by inspection alone whether this virus is present or not, except in the severer strains, and roguing cannot be relied upon to eliminate the virus.

All the evidence suggests that virus X is not insect-transmitted, but Loughnane and Murphy¹ have demonstrated that it can spread from diseased to healthy plants in the field by contact of the haulms. In view of the widespread distribution of this virus, however, it is possible that other means of spread exist, and co-operative experiments are now being carried out in different parts of England and Wales to investigate this question.

Although the majority of Scotch seed potatoes are considered healthy, they are not virus-free, for that, as we hope to show, is not the same thing at all. As we have mentioned already, it is not possible to say by inspection alone whether a given potato plant is virus-free. Several careful tests must be carried out under controlled conditions in a glasshouse before that conclusion can be reached. Briefly, the tests consist first of inoculation to various plant species which are particularly sensitive to the several potato viruses (indicator plants), and secondly of grafting to susceptible varieties of potato. If all these tests are passed successfully, then the potato plant in question can be pronounced virus-free, and here we may remark, incidentally, that very few Scotch seed potatoes will pass these tests.

Where then can virus-free potatoes be found? At the Plant Virus Research Station at Cambridge are nucleus stocks of all the commercially popular potato varieties which have been grown in insect-

proof glass-houses and rigorously tested for virus infection each year. These stocks were originally built up by Dr R. N. Salaman, and since his retirement in 1939 they have been carried on and added to by us. There are, therefore, available small stocks of these potatoes which are definitely virus-free, including such varieties as Kerr's Pink and Up-to-Date which cannot be obtained elsewhere in this condition.

Obviously, however, such nucleus stocks are not going to benefit the seed potato trade unless they can be increased to an extent not possible with glasshouse culture. This multiplication is now being undertaken in co-operation with the National Institute of Agricultural Botany, and the procedure is as follows: the nucleus virus-free stocks of some twelve popular varieties were planted and grown under expert supervision in the best seed potato districts of Northern Ireland. As soon as a sufficient bulk of tubers was raised, the next step was to grow them in still more complete isolation. This has been achieved by planting the tubers on a small island—Islay by name—off the west coast of Scotland, where no other potatoes are grown. It is hoped that in about two years time several thousand tons of virus-free seed potatoes will be available.

Periodically samples of tubers are returned to Cambridge from Ireland for re-testing, and in 1944 1500 tubers which had been grown out of doors for three seasons were tested. Of these the great majority was still virus-free, though a few tubers of a particular line of Majestic potatoes were X-infected. We have reason to believe that some of these Majestic tubers might have been already infected before their dispatch to Ireland. This stock of Majestic was discarded. It seems clear from this and other experimental work that virus X spreads very slowly in the field, potato virus workers in Eire² have maintained certain potato stocks free of virus for several years by growing the plants in isolation and out of contact with each other.

RESULT OF ANALYSIS FOR VIRUS CONTENT OF EIGHT VARIETIES OF
SCOTCH STOCK SEED POTATOES

Variety	No. of tubers tested	No. of X-infected tubers
Arian Peak	Four	One
Arran Victory	Twelve	Twelve
Eclipse	Thirty-six	Thirty-six
Gladstone	Four	None
Great Scot	Nine	Nine
Kerr's Pink	Twelve	Twelve
Majestic	Fifteen	Five
Sharps' Express	Twelve	Four

It should be noted that these tubers were from plants specially selected as healthy by a competent potato inspector in an attempt to increase the virus-free stocks at Cambridge.

Since the visible effects of the mild strains of X which are the commonest, are so slight, the question may rightly be asked whether it is worth while to raise and maintain virus-free, and particularly X-free potato stocks. In other words, does infection with virus X reduce the yield? This is the whole crux of the matter. Scott³ in Scotland has carried out trials to investigate reduction of yield by virus infection. As his healthy control plants he used Stock Seed Certificate tubers and compared these with infected plants of four categories: (1) negligible mottle, (2) mild mosaic, (3) border-line severe mosaic, (4) severe mosaic. Scott's results show that the least severe infection—negligible mottle—reduced the yield by about 13 per cent as compared

with his 'healthy' plants. Since it is probable that Scott's healthy plants were also X-infected (see our analysis of Stock Seed tubers), what he was actually doing was correlating reduction in yield with severity of symptoms. The question that really needs answering is: Does the presence of virus X in a given potato variety materially reduce the yield when there is little or no visible adverse effect upon the plant itself? There seems little doubt that there is a considerable reduction in yield. Bald⁴ in Australia has published some results of experiments on these lines. He made field trials on Up-to-Date potatoes, grading the severity of strains of X present in twenty-five families on the basis of their symptoms on an indicator plant (*Datura*). Bald estimated that the yield from completely healthy plants should be some 12 per cent higher than that from plants infected with the mildest strains of virus X.

Taking advantage of the opportunity offered by the 5,500 tubers from Ireland previously mentioned, all of which had been tested and found to be virus-free, a comparatively extensive yield trial was carried out at Cambridge. The potatoes used consisted of one early variety, one second early, three early main crops and four late main crops.

The potatoes were planted in sixty plots, each of our rows of ten half-tubers, and the middle two rows only of each plot were weighed on sampling. As soon as the plants were six inches above ground, half the plants were inoculated with a very mild strain of X derived from some Stock Seed Arran Peak potatoes. This strain of virus was deliberately chosen for its mildness and was by no means the most severe of those isolated from tubers having a Stock Seed certificate.

Some weeks later, twenty-five of the inoculated plants were selected at random and tested for the presence of virus, and all gave a positive reaction for virus X. It thus seems fair to assume that the inoculations had been effective, although it was not possible during the summer to pick out the inoculated plants by inspection.

On harvesting and weighing the tubers, it was found that the yield from the inoculated plants was 12 per cent below that of the virus free plants, a difference which is highly significant. All the varieties showed reduction in yield from infection by virus X, but the data are not sufficient to differentiate varietal reaction with certainty. During the season, 105 of the healthy plants which were afterwards harvested were tested and found to be still virus-free.

These results seem to prove that infection with virus X, even with those strains which are normally passed over by the Scotch potato inspectors, results in a considerable loss of crop.

What evidence we have suggests that the elimination of potato virus X from the Scotch seed potatoes is by no means impossible. Since it appears that the spread of virus X in the field is slow and there is little evidence of its infiltration into a crop completely free from the start, the solution apparently lies in a gradual replacement of the X-infected Stock Seed, and in this process we hope that the stocks built up by the Plant Virus Research Station in conjunction with the National Institute of Agricultural Botany may play their part.

SOIL CONSERVATION IN THE BRITISH COLONIAL EMPIRE

A RECENTLY published article, "Soil Erosion and Soil Conservation in the Colonial Empire", by H. A. Tempany, G. M. Roddan and L. Lord (*Emp J Exp Agric*, 12, 121, 1944), brings the story of soil conservation in the British Colonies up to date. Much of the story is by now well known, and should be still better known, for it concerns closely the future welfare and sometimes the very existence of British Colonial territories. The menace of soil erosion has perhaps been somewhat exaggerated in the past, if so, it has been done with good reason, for the action necessary to remove the menace has only been taken after the people and more particularly the government authorities in London and the Colonies were thoroughly aroused by fear of catastrophe. Soil erosion is still prevalent and increasing throughout Africa, Ceylon, the West Indies and the Mediterranean Dependencies, but the fear of it seems to be abating. It has been shown that erosion can be controlled by apparently simple measures. As yet there are few areas where it has been completely controlled, but the knowledge that it can be has engendered confidence that it will be, and there is a tendency now to play down the menace, which in fact is neither greater nor less than it was.

The War has had a certain, not entirely unfavourable, influence on the progress of soil conservation. It has seriously depleted staffs and held up the construction of anti-erosion works which are often urgently needed, but at the same time it has helped to eliminate one of the root causes of soil depletion and erosion, namely, agriculture for export in a world market. The immediate effects of the War on soil-conservation programmes have undoubtedly been serious, but the long-term effects in promoting a change in methods of land utilization may be beneficial.

Many Colonial administrations now take a direct part in soil conservation, either through government-operated soil-conservation boards or committees, or by propaganda, education and the granting of subsidies for anti-erosion work. An important function of government is to promote co-operation between different departments (for example, of agriculture, forestry, public works, etc.), for soil conservation is the concern of the whole community. The authors give several instances where such co-operation is being realized with great advantage to the land. An important recent factor has been the provision of money from the Imperial Treasury through the Colonial Development and Welfare Fund for soil-conservation works.

Short accounts are given of the state of erosion and of the counter-measures being taken in each of the Colonial dependencies. The first impression given is that soil conservation is much the same everywhere. The following quotation refers to Basutoland, but the words are repeated with little variation in describing conservation measures in most of the other Colonies.

"The measures adopted comprised the laying out of contoured, broad-based terraces and the introduction of ploughing along the contour, the construction of earth-dams to check gully erosion and provide additional water-supplies for stock, combined with the planting of grass and trees to stabilize

¹ Loughnane, J. B., and Murphy, P. A., *Sci Proc Roy Dublin Soc*, 22, 1 (1938).

² Clinch, P., Loughnane, J. B., and Murphy, P. A., *Sci Proc Roy Dublin Soc*, 22, 17 (1938).

³ Scott, R. J., *Scott J Agric*, 23, No 3 (1941).

⁴ Bald, J. G., *Aust Coun Sci Indust Res Bull* 165 (1943).

contour banks and to assist the silting up of gulches, and the fencing of the banks of dams and of plantations to prevent damage by live stock.

"Combined with these measures there must be improved methods of agriculture based on the introduction of mixed farming in place of the existing system. It is considered that the maintenance of crumb structure in the soil should be the aim and that this can only be maintained by suitable agricultural methods."

Many of the Colonies are still at the early contouring stage of soil conservation, at which the most urgent need is to construct mechanical barriers to run-off water and eroding soil. Some have reached the 'strip-cropping' stage, where contour cultivation is combined with an appropriate variant of ley farming, with the purpose of maintaining a crumb structure which will enable the soil to resist erosion with less absolute reliance on engineering constructions. Particular note may be taken of the remarkable success in restoring soil condition and fertility on exhausted land, achieved in Uganda by strip-cropping with elephant grass. Simultaneously, and not only in Uganda, local inhabitants are increasingly appreciating the value of livestock as an integral part of farming and not merely as a symbol of wealth.

Throughout the British Colonial Empire, agriculture is evolving at an accelerating pace from primitive, shifting cultivation to settled, intensive systems. There is danger now, as there has been always, that evolution may get out of hand, but at least we know what the goal is, we can even define it in terms of the physical properties of a fertile, erosion-resistant soil, and we know what agricultural operations will or will not advance the goal. The task of the future will be to synthesize the separate favourable operations into workable systems of land use. The engineering problems of soil conservation have been solved, the agricultural problems are well on the way to solution, and last, but by no means least, the complex social problems still remain to be solved.

OBITUARIES

Sir Charles Vernon Boys F.R.S

CHARLES VERNON BOYS was born at Wing in the county of Rutland on March 15, 1855, the son of the Rev. Charles Boys. Wing continued to be his home for many years, and it was in his father's garden there that Boys thirty-three years later made with his radio-micrometer his well-known experiments on the heat received from the moon and stars.

At the beginning of his delightful little book on "Soap Bubbles and the Forces which Mould Them", Boys tells how his interest in science was first awakened. "To G. F. Rodwell, the first Science master appointed at Marlborough College, this book is dedicated by the author as a token of esteem and gratitude, and in the hope that it may excite in a few young people some small fraction of the interest and enthusiasm which his advent and his lectures awakened in the author, upon whom the light of Science then shone for the first time."

From 1873 until 1876, Boys was a student at the Royal School of Mines. In his Guthrie Lecture, delivered before the Physical Society of London in 1934, he mentioned that he was for a short time at a colliery, and that he was brought back to South Kensington by Guthrie, who made him his private

assistant and gave him a life membership of the Physical Society. His connexion with that Society always remained a close one, he succeeded Guthrie as its demonstrator in 1886 and continued to be demonstrator and librarian until 1898, he was later to become its president and was its second Duddell medallist. It was to the Physical Society that much of his work was communicated, including his first paper on "A Condenser of Variable Capacity and a Total Reflection Experiment". This was published in 1879, and in the title Boys is described as "Lecturer for the term on Natural Science at Uppingham School". In this and the following year papers were published by Boys and Guthrie on "Magnetic Induction" and by Boys himself "On an Integrating Machine". The latter was the first of many papers dealing with practical mathematics including one on "An Elliptograph" published in his eighty-ninth year.

Boys was demonstrator of physics at the Royal College of Science, South Kensington, from 1885 until 1889, when he became assistant professor. Much of the work for which Boys is best known was carried out or begun during the years 1887-90. A preliminary note on the radio-micrometer was communicated to the Royal Society on February 24, 1887. In the tests of the method there described he had used spun glass for the suspension of his radio-micrometer. In a note added a month later, he stated that he has since found a method of producing fibre immensely superior to those of spun glass. These fibres of fused quartz obtained by his bow-and-arrow method were described in a paper, read before the Physical Society a little later in the same year, on the production, properties and some uses of the finest threads. The many uses of threads of fused quartz made possible by their perfect elasticity and great strength are there pointed out. An account of the perfected radio-micrometer was given to the Royal Society in the following year. He found a suitable application for the instrument in an investigation "On the Heat of the Moon and Stars", begun in September 1888 and published in the *Proceedings of the Royal Society* two years later. Boys found the radio-micrometer amply sensitive for the comparison of the heat received from different small areas of the moon's surface, it gave no certain indication of any heat received from even the brightest star although able to detect the heat received from a candle flame more than a mile away.

In 1889, Boys communicated to the Royal Society his ideas on improvements in the Cavendish experiment to determine the constant of gravitation, pointing out the advantages of reducing the scale of the apparatus, the use of a fibre of fused quartz for the suspension made it practicable to carry this reduction very much further than would otherwise have been possible. Boys' final measurements of the Newtonian constant of gravitation were carried out in the Clarendon Laboratory, Oxford, and published by the Royal Society in 1894. He had succeeded in reducing the length of the torsion rod from which the attractive masses were suspended from the six feet of the original Cavendish experiment to less than one inch; the measurement was more accurate than any previously made of the constant of gravitation.

From indications which he had observed of the high electrical insulating power of quartz fibre Boys was led to make investigations on quartz as an insulator, which were published in 1890. Besides proving the great merits of quartz as an insulator

these experiments gave very strong indications that some at least of the leakage of electricity from a charged body suspended in a closed vessel is not through the insulating support but by conduction through the air

An account of experiments with a soap bubble was given by Boys to the Physical Society in 1888, and in December 1889 and January 1890 he delivered the Christmas Lectures before a juvenile audience at the Royal Institution, which formed the basis of his well-known book on soap bubbles referred to at the beginning of this notice. In this subject Boys found ample scope for the exercise of his wonderful ingenuity and manual dexterity.

Notes on photographs of rapidly moving objects and on the oscillating electric spark formed the subject of a communication to the Physical Society in 1890. He gave a popular lecture at the Edinburgh meeting of the British Association in 1893 in which he showed photographs of rifle bullets in flight and the air waves accompanying them. In a note communicated in 1937 to the Royal Society of Edinburgh, of which he had recently been elected an honorary fellow, he directs attention to the high speed of rotation given to a mirror by very simple means in these early experiments. He had used the rotating mirror to measure times as short as one hundred millionth of a second, and by its aid had found how to get an illuminating spark which lasted for only one thirteen-millionth of a second.

It was in 1888, in the midst of this wonderfully active period of his scientific life, that Boys was elected a fellow of the Royal Society, he was awarded a Royal Medal in 1896 and the Rumford Medal in 1924.

In 1897 Boys became one of the Metropolitan gas referees. He greatly improved the methods of gas calorimetry, and the calorimeter described by him in the *Proceedings of the Royal Society* in 1903 was adopted as the standard instrument for testing London gas, it came into general use in gas-works throughout Great Britain. He devoted much thought, during many years to the planning of a still better gas calorimeter, but it was not until 1934 that he finally arrived at a design which completely satisfied him. This was described in his Guthrie Lecture of that year. Boys tells in this lecture that the idea underlying one important part of the mechanism came to him in a dream. "I was sufficiently impressed by it to get up at six and go to Victoria Street, where I blew in glass the bulb and tube you now see." He was then in his eightieth year.

It is not surprising that Boys, after his experiments with electric spark discharges, should take an interest in the development of a lightning discharge. With the object of investigating this subject, of finding, for example, at what part of its path the discharge begins and the speed with which it extends itself, he constructed in 1900 a moving-lens camera, of which he gave a short description in *Nature* of November 20, 1926. Although he was in the habit of carrying this camera about with him, it was not until twenty-eight years after its construction that, while staying with Loomis in America, he succeeded in getting his first photograph which showed the progressive development of a lightning discharge. Boys must have been interested in lightning for at least half a century when this photograph was taken, for in the issue of *Nature* mentioned above he gives a most interesting account of observations of a distant thunder cloud which he had watched at Wing in 1876. For every

flash seen in the rain cloud or below, and simultaneously with it, one or more very slender flashes of typical lightning (in one case as many as seven) were observed to shoot upwards into the clear sky.

In spite of the handicap of the loss of one eye and very defective vision in the other, Boys continued his varied scientific activities until the end of his long life, when he was eighty he published little books on the natural logarithm and on weeds. It was in this year that he received his knighthood.

Boys does not appear to have been greatly interested in theoretical physics. His delight was in designing, constructing and manipulating apparatus for physical measurements of the highest accuracy, and in overcoming experimental difficulties which to most would have seemed insuperable. He was a really great experimenter, and his methods of working were original and often unconventional. He appears to have been equally original and unconventional in ordinary life.

Boys married in 1892 Marion Amelia, daughter of the late Henry Pollock, and they had one son and one daughter, the marriage was dissolved eighteen years later.

Boys died on March 30, 1944, in his ninetyeth year.
C T R WILSON

Mr J A Gaunt

News has recently reached Great Britain of the death of Mr J A Gaunt on January 4, 1944, he died from myelitis as a prisoner of war in Hong Kong.

Gaunt entered Trinity College, Cambridge, from Rugby as a scholar in 1923, and had a distinguished undergraduate career, obtaining a mark of distinction in the Mathematical Tripos in 1926 and sharing the newly instituted Mayhew Prize. He then started to work on theoretical physics under the late Sir Ralph Fowler and soon became one of the most promising members of the rapidly expanding school which was being established at Cambridge in the latter half of the 1920's.

Gaunt's first paper was on the stopping power of matter for α -particles and was completed by March 1927. He next turned to statistical mechanics and extended some work by Fowler and by Eddington on stellar atmospheres. For this work, published under the title "The Debye-Huckel Theory and Stellar Atmospheres" (*Mon Not Roy Ast Soc*), he was awarded a Rayleigh Prize in 1928. He then returned to the more congenial topic of quantum mechanics and wrote a number of short papers in rapid succession on such subjects as the theory of Hartree's self-consistent field and the relativistic theory of an atom with many electrons.

These early papers of Gaunt's were useful contributions to a rapidly growing subject, but his most important work is contained in two long and rather formidable papers published in the *Phil Trans.* during 1929 and 1930, the first being on the triplets of helium and the second on continuous absorption.

The problem of calculating the triplet separations in helium was first tackled by Heisenberg, using non-relativistic quantum mechanics. The calculation is more difficult for helium than for heavier elements, since for helium the usual approximate theory is inadequate, retardation and other relativistic effects being of comparable importance to the spin-orbit and spin-spin interactions. When Dirac's relativistic theory of the electron appeared it was possible to

extend Heisenberg's work, and Gaunt was first in the field. His work has been superseded by that of others, notably by that of Breit, based upon a more thoroughgoing derivation of the fundamental equations from quantum-electrodynamics, but Gaunt made a very substantial contribution to a difficult problem.

In the 1920's the calculation of the absorption coefficient of matter for radiation was of great importance in astrophysics. Kramers' formula, based upon the old quantum theory and the correspondence principle, was in violent disagreement with the value of the absorption coefficient required according to the current astrophysical theories. It was therefore of considerable importance to calculate what the absorption should be according to wave mechanics. This was first done by Oppenheimer, who obtained a formula substantially different from Kramers'. Gaunt, who was working on the same problem, discovered an important mistake in Oppenheimer's calculations and rehabilitated Kramers' formula. He also extended Oppenheimer's work considerably.

These two long papers were completed in little more than twelve months work, and show Gaunt's great ability to handle complicated mathematical problems. It is remarkable that Gaunt should have been able to achieve so much in a single year, since he had already determined to give up theoretical physics for what he considered to be more important work. He was elected a research fellow at Trinity in October 1929, but never resided. Instead, he left England and went, under the auspices of the Church Missionary Society, as an assistant master at St Stephen's College, Hong Kong, where he taught mathematics, English and Scripture to Chinese and

Siamese boys. He acquired a good knowledge of Chinese, and his pupils liked and admired him, but were genuinely perplexed how a man of such ability came to be their teacher.

Gaunt never lost his interest in physics and found time to read such papers as were sent out to him by friends. Music gave him great pleasure, as did the opportunities he had for travel in China, especially in the mountainous regions. When the shadow of war hung over the Colony, Gaunt joined the Volunteer Defence Corps as a gunner, and took part in the brief struggle.

Gaunt was somewhat reserved with most people but he had a strong sense of humour and a ready sympathy in the everyday affairs of life. It must have cost him much to make the sacrifice of going to China, but it was done with perfect cheerfulness in obedience to his conviction of the supreme importance of Christianity. A. H. WILSON

We regret to announce the following deaths

Prof. R. Bennett Bean, professor of anatomy in the University of Virginia during 1916-41, known for his work on the distribution, development and evolution of man, on September 3, aged seventy.

Lieut.-Colonel J. W. F. Brittlebank, C.M.G., president of the Royal College of Veterinary Surgeons during 1926-28, on December 18, aged sixty-eight.

The Rev. E. Tickner Edwardes, well known for his popular writings on bees and on general natural history, on December 31, aged seventy-nine.

Dr. J. Fitch King, professor of chemistry in Williams College, Williamstown, Massachusetts, on August 29, aged forty-nine.

NEWS and VIEWS

Prof. A. N. Whitehead, O.M., F.R.S.

THE award of the Order of Merit to Prof. A. N. Whitehead, of Harvard University, announced in the New Year Honours, will be widely acclaimed. Prof. Whitehead was first known as a mathematician, though of an unusual kind. Mathematics for him meant the "development of all types of formal, necessary, deductive reasoning" (preface to "Universal Algebra", 1898). This phase of his career culminated with the publication of "Principia Mathematica" (1910-12). It was afterwards, as most of us thought, that he turned to philosophy—with a remarkable contribution to the theory of knowledge in 1919-20, and later with a complete system of metaphysics expounded in a series of well-known works. It has been pointed out by Prof. V. Lowe (essay in "The Philosophy of A. N. Whitehead", 1941) that there was no sudden change, the philosopher was implicit in the mathematician, as could be seen in a paper of 1905.

Whitehead's later works have been much read and quoted—often misread and misquoted. That is the fate of a writer who is at times obscure, at times brilliantly epigrammatic. It is characteristic of his attitude to emphasize the need for abstract thought and also the fallacies that arise from it, the need for rule and order in life and also that mere order means futility. Whitehead's essays on the aims of education are too little known. Nobody has argued more persuasively for the value of history in educa-

tion. As is more widely known, few have viewed human history with so keen and comprehensive an eye, and so wide and fine a sympathy.

Organization of Science in Great Britain

AN interim memorandum from the sub-committee on the future scope and organization of science in Great Britain which has been issued by the Parliamentary and Scientific Committee urges as an immediate measure the appointment by the Government of a committee, with the widest powers of securing information, to review the existing position of industrial research and development in British industry and to plan a programme (covering, say, the next five years) aimed at remedying the most important defects and gaps in that field, so far as the national interest is concerned. Such a review would involve consideration of existing national resources at home, the probable economic position of Britain in the post-war world, and the lines along which the immediate vigorous and large-scale application of scientific knowledge is likely to yield the most fruitful results. In this connexion the sub-committee stresses the necessity for special attention to scientific research on the treatment of coal. The review would also involve investigation into the points at which British industry in general, and certain industries in particular, have failed in the past to utilize scientific knowledge, the loss to the national interest which has resulted from this failure and the steps which

n be taken to prevent the recurrence of similar future. The sub-committee does not consider that a view of this type, involving specialized technical knowledge of a number of different industries, combined with a particular appreciation of the facts affecting the position of Great Britain in the world economy, could be adequately carried out by any existing agency. While the proposed committee should take as evidence in secret, an early and informative report regarded as essential, first as a means of bringing some to industry and the public the realities of the existing situation, and secondly, to afford a basis for settling the plan of action required to recover and maintain the industrial strength upon which our future as a nation depends.

Newton and His Portraits

MR F E BRASCH, of the United States Library of Congress, has selected some of the best portraits of Newton for publication in *Scripta Mathematica*, 199, (1941). The earliest is by Sir Peter Lely, and is supposed to show Newton (who was born on Christmas Day, 1642, Old Style) as he appeared in 1665 (the year of the Great Plague), but there is some doubt whether Newton sat for this. The first portrait that can be guaranteed authentic is by Sir Godfrey Kneller, and is dated 1689, two years after the publication of the "Principia". The other portraits all show Newton as president of the Royal Society, a position he held from 1703 until his death in 1727. One is by William Gandy (1706), four by Johann Vanderbank (1720, 1725, 1726 and 1726 again), and one by an unknown artist. There are also photographs of a bas-relief attributed to Wedgwood, of a bronze statue by the American sculptor E. Dallon (1897), and of the reconstruction in Wellesley, Mass., U.S.A. of the actual parlour from Newton's house in Leicester Fields, St. Martin's Street, London.

In another article (*Science*, 99, 437; 1944), Mr Brasch gives us some information about the influence of Newton on Russian science. For some unknown reason, Newtonian ideas were ignored in Russia long after they had been accepted in France, Germany and other countries. Indeed, it was not until quite recently that the formal recognition of his work became evident. His "Optics" was translated into Russian in 1927, and the "Principia" in 1936. However, the celebrations of the tercentenary of Newton's birth left nothing to be desired. They were on an impressive scale, much exceeding those in Great Britain, and culminated in the founding of fifteen Isaac Newton studentships.

Texas Meteor Cloud

OSCAR E MONNIG has described the effects of a fireball observed on May 20 over Texas (*Sky and Telescope*, September). It travelled from west to east and left a meteor cloud, photographs, some of which are reproduced, were taken by different people. Unlike some fireballs, this one did not leave a persistent train, two minutes after Ray Dudley, in the middle of Pampa, had taken a photograph, he was able to secure another one which showed a great change, not only in the brilliance of the meteor cloud, but also in the amount of diffusion that had taken place. The sun had set 40 minutes in some places and 20 minutes in others when it was seen, and as it was visible for a radius of more than 300 miles, it must have been a very imposing object at

first. Atmospheric resistance slowed down its speed, which was almost below that of incandescence 13 miles north-west of Pampa. Attempts to find fragments of the fireball, which almost certainly disintegrated (though there is no record of a report due to disintegration such as is often heard with fireballs) have so far been unsuccessful, but it is hoped that some of the debris will be obtained. A provisional path has been computed, and it appears that it became visible at a height of 56 miles, the dense cloud being formed at a height of 23 miles (this latter is considered very accurate), and its direction of flight was at an angle of about 45° to the horizon.

Insect Pest Resistance in Plants

THE Imperial Bureau of Plant Breeding and Genetics, Cambridge, has issued a Bibliography on Insect Pest Resistance in Plants (1s. 6d.). The sources drawn upon include publications from the British Commonwealth, the main European countries, the United States and various South American countries, the U.S.S.R. and Japan. In all, there are more than 550 references arranged according to subject, the chief of these being cereals, roots and tubers, cotton, sugar-cane, fruits and vegetables. Nematodes are dealt with in a special section. Many of the publications included have been abstracted in *Plant Breeding Abstracts*, and in many instances the original publications cited are available at the Bureau or in some co-operating library, and further information can therefore, if necessary, be obtained on application to the Bureau. It is believed that the bibliography will be of practical assistance not only to the breeder and the geneticist, but also to all who are interested in the solution of the important problem of the fundamental basis of insect or nematode resistance among crop plants.

Poliomyelitis in Argentina

THE July issue of the *Boletín de la Oficina Sanitaria Panamericana* contains an instructive article by Dr. G. Bayley Bustamante, assistant professor of public health, Buenos Aires, dealing with the last outbreak of poliomyelitis in the Argentine (October 1942–May 1943 with 1,948 cases). This was probably the largest outbreak, although epidemics were reported in 1909, 1911, 1916–17, 1919–20, 1924–25, 1932–33, 1934–35 and 1936, mostly in the Buenos Aires and Rosario Area, with smaller outbreaks and sporadic cases in the rest of the country, but paralytic cases figure in the statistics in 1941. There were 355 cases (189 in the Province of Santa Fé), which was an increase on the usual yearly figures. The 1942 epidemic in the southern suburb of Buenos Aires then extended into the city and to the rest of the province, with the peak in November and December, it increased along the coast after January and moved northward. The incidence was highest in the Buenos Aires sector. Half the cases were in children aged 1–3 and another 10 per cent in those less than 1 year. The death-rate ranged from 3.5 to 23–25 per cent, usually being 10 per cent. Of the eight large Argentine epidemics, four began in February and one each in June, September, October and November. The 1942–43 epidemic had its peak in October–November (spring), the year had been characterized by a hard but short winter, an early warm spring and a very hot and dry summer.

Leprosy in the Dominican Republic

ACCORDING to Dr Guillermo Iliviera (*Bol. Of. San. Panamer.*, 22, 987, 1943), medical superintendent of the National Leprosarium of the Dominican Republic, 212 cases of leprosy have been treated there during the period 1922-42, or are still confined there. 142 were men and 70 women. There were 75 deaths and 23 births. 147 cases were from the southern zone, while 44 were from the northern zone, the central area was practically free from the disease. Estimating the total number of lepers in the Republic both in and out of the leprosarium at 224, one obtains a ratio of one leper per 8,500 inhabitants, which is much lower than that of India (1 per 3,000) and Japan (1 per 1,000).

Performance of Cable Terminations

IN a paper read by D. B. Irvin before the Institution of Electrical Engineers in London on November 8, the performance, over the period of twelve years ended 1943, of the cable terminations on the British Grid system at voltages between 3.3 kV and 132 kV is reviewed, and the causes of breakdown are examined. For the period under review, termination failures account for approximately 40 per cent of the total cable circuit faults and they are classified as follows: design 39, workmanship 2, design or workmanship 18, maintenance 9, and system conditions 12. Failures on 6.6, 11 and 33 kV circuits predominate. The failures attributed to design and workmanship were mainly due to imperfect stress control, inadequate internal clearances, compound migration, and presence of moisture, the incidence of these is discussed in the paper. The fundamental characteristics required of a cable termination are (a) ability to withstand the electrical stresses associated with normal and emergency conditions of the voltage of the system and the occasional high-voltage impulses to which it will be subjected in service, (b) ability to carry the maximum rated current of the circuit and the maximum fault current of short duration to which the circuit is liable, (c) retention of its initial electrical and mechanical qualities without deterioration, during the statutory life of the cable circuit in which it is incorporated, and (d) economic cost to the user. Sectional drawings are included showing improved designs of sealing ends for various sizes and types of cables for voltages ranging from 3.3 to 132 kV, and the salient features of these are discussed briefly.

Design of A.C. Turbo Generators

IN a paper read by G. A. Juhlin on December 7, before the Institution of Electrical Engineers in London, on the standardization and design of A.C. turbo-type generators, the possibilities of complete unification of designs, an alternative of mechanical interchangeability, and the standardization of requirements, which is the first step in either of these directions, are considered in turn. The author discusses standardization of design, future development, and standardization of requirements, which latter is the really valuable part of the paper. The conclusions arrived at are that for both commercial and technical reasons complete unification of designs must be regarded as impracticable under present conditions, and it seems very doubtful whether the alternative of mechanical interchangeability would be feasible.

Announcements

DR F. W. ASTON has been awarded the twenty-first Duddell Medal of the Physical Society, recognition of his invention and development of the mass spectrograph.

PROF G. M. BENNETT, University professor of chemistry at King's College, London, since 1938, has been appointed Government chemist in succession to the late Sir John Fox.

THE title of emeritus professor of geography in the University of London has been conferred upon Prof E. G. R. Taylor, in recognition and appreciation of her distinguished services to the University and her subject.

FOLLOWING on the recent appointment of Prof J. A. Scott Watson as chief education and advisory officer to the Ministry of Agriculture and Fisheries, the Minister, in preparation for the setting up of the National Agricultural Advisory Service, has appointed the following senior education and advisory officers as from January 1: Mr F. Rayns, Dr W. Slater and Dr H. V. Taylor. Mr Rayns's appointment is on a part-time basis, and he will continue to act as director of the Norfolk Experimental Station, Sprowston. He is succeeded as executive officer of the Norfolk War Agricultural Executive Committee by Mr J. C. Mann, who was deputy executive officer of the Committee.

THE Therapeutic Research Corporation has elected the following officers for the year 1945: chairman, Lord Trent (Boots Pure Drug Co., Ltd.), in succession to Mr H. Jephcott (Glaxo Laboratories, Ltd.), deputy chairman, Dr F. J. Carr (The British Drug Houses, Ltd.), chairman of the Research Panel, Mr F. A. Robinson (Glaxo Laboratories, Ltd.), in succession to Dr A. J. Ewins (Miles and Baker, Ltd.), deputy chairman, Dr C. J. Kellaway (Wellcome Foundation, Ltd.), in succession to Mr F. A. Robinson (Glaxo Laboratories, Ltd.).

IN view of the importance which civil air transport will assume after the War, the Council of the Institution of Civil Engineers has decided to form a six-member Engineering Division to be known as the "Air Transport Division", to deal with such aspects of air transport as airports (land and sea), airfields, operation buildings and facilities, hangars, and signalling and other appliances in connexion with safety in flying. Until such time as a fully constituted division board has been elected, Mr M. G. J. McHaffie has been appointed chairman of a provisional board.

THE twenty-seventh election to Beit Fellowships for Scientific Research will take place on or about July 7, when not more than three fellowships will be awarded. Candidates may be of any nationality but must be of European descent by both parents and must be of university degree standing. Forms of application and all information may be obtained, in letter only, addressed to the Registrar, Imperial College, South Kensington, London, S.W.7, to whom they must be returned on or before April 6.

AT a meeting of the Physical Society to be held at the rooms of the Royal Society on January 19, at 5 p.m., a lecture on "Imperfections of Crystal Lattices as Investigated by Study of X-Ray Diffraction Scattering" will be delivered by Dr A. Guinier, of the Laboratoire d'Essais, Conservatoire National des Arts et Métiers, Paris.

LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications.

Dextran as a Substitute for Plasma

As is well known, we have in blood, plasma and an adequate media for the treatment of shock, for example, in cases of serious loss of blood or atusions. During the present War, however, it has proved impossible completely to supply the large requirements of these materials. It is therefore natural that physiologists and chemists are seeking substances the aqueous solutions of which can replace the expensive and delicate blood or plasma. In the course of the War of 1914-18, Bayliss¹ attempted to employ solutions of gum arabic for purposes of infusion. Later, other substances such as latex, polyvinyl alcohol, pectin, polyvinylpyrrolidone and others were tested to this end. The infusion of these colloids has, however, been attended by certain difficulties. Some of the substances tested gave antigenic properties, whereas others cannot be taken down by the organism, for which reason they are stored in the organs, especially in the liver. The conditions to be fulfilled by a foreign colloid in order that it may exercise a therapeutic effect in cases of shock are, in brief, as follows.

In all cases of shock, both in bleeding and in contusions and burns, it is essential to increase the volume of the circulating blood by the infusion of a fluid. This cannot be done satisfactorily with solutions of crystalloids. The infused liquids must instead contain colloids that exert the same colloidal osmotic pressure as the plasma proteins, or 300-400 mm. water. A condition for the exertion of this pressure by the colloids is that they must be of such a molecular size that they cannot pass through the walls of the capillaries.

The colloid must be suited to repeated intravenous injection in large quantities. It must also be completely atoxic and devoid of antigenic properties. The solutions must not have a high viscosity. The viscosity should preferably be of the same order as that of the blood.

Finally, the substance should be of such a nature that the body can gradually rid itself thereof, so that it does not remain long in the blood and is not stored in the organs.

A substance not previously tested for this purpose and apparently fulfilling the requirements listed above is the neutral polysaccharide dextran. Dextran is water-soluble high-molecular carbohydrate which is formed in solutions of sugar infected with the bacterium *Leuconostoc mesenteroides*. It has been possible to show that the dextran molecule is built up of glucose units, linked together in long, more or less branched chains². The molecular weight of dextran may be very high, of the order of magnitude of many millions^{3,4,5}. By partial hydrolysis dextran preparations of lower molecular weight, for example, of the order of 100,000-200,000, can be made⁶. The partially hydrolysed dextran, like the original substance, is inhomogeneous with respect to molecular weight.

By well-controlled partial hydrolysis it is possible to prepare dextran solutions for purposes of infusion in which the solute has a suitable molecular weight and which do not give rise to injuries or reactions even after repeated large infusions. The sedimentation

reaction, however, is increased after infusion (which has also been observed after infusion of, for example, gum arabic). The viscosity and colloidal osmotic pressure of the 6 per cent solutions employed (with 1-3 per cent sodium chloride) are of the same order as those of blood.⁷

The solutions can be autoclaved and the preparation distributed in concentrated solutions or in the form of dry powder.

If a normal infusion dose is injected intravenously into a dog, the dextran concentration in the blood falls to zero in the course of three to four days. During the whole of this period dextran can be detected in the urine. The dextran ejected with the urine has a lower molecular weight than that originally injected. Even after repeated large infusions, no storage in the organs can be demonstrated histologically.⁷

As dextran is broken down by the organism, glucose and relatively low-molecular fragments of dextran are presumably formed, which can pass the kidney filter and be expelled with the urine.

The therapeutic effect was investigated experimentally in cases of shock from bleeding, histamine shock and contusion shock developed artificially in rabbits and cats. Rapid and lasting effects on the blood pressure, heart action and respiration were always registered.⁸

The experiments on animals giving favourable results, a clinical investigation was therefore commenced, at first on a limited scale. As the first clinical tests also gave promising results, and as there is reason for supposing that dextran is better suited as a plasma substitute than, for example, gum arabic, polyvinylpyrrolidone or pectin, it was considered justified to set in train a more thorough clinical investigation. An account of this will be submitted at a later stage.

We wish to thank Prof. Arne Tiselius for helpful advice and Profs. T. Svedberg and A. Westerlund for the provision of laboratory facilities. The research has been carried out with grants from A. B. Pharmacia, Stockholm, and Svenska Sockerfabriks A. B., Malmö.

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Reactivity of the Sulphur Linkage in Wool

WHEN a wool fibre is rubbed lengthways between finger and thumb, it migrates in the direction of the root end because the surface consists of a series of overlapping scales. Similarly, when a fabric containing wool fibres is rubbed in presence of aqueous media, the fibres migrate and cause the material to shrink. Such shrinkage is usually prevented by treating the fabric with compounds which are capable of forming a gelatinous degradation product of keratin on or under the scales of the fibres. A survey

of the properties of these compounds suggested¹ that any reagent which is capable of causing disulphide-bond breakdown should make wool fabrics unshrinkable if it is applied under conditions such as to restrict its action to the surface of the fibres. Confirmation of this deduction has since been provided by the discovery of methods for conferring an unshrinkable finish on wool by means of sodium hydroxide², sodium sulphide³, and alkaline solutions of mercaptans⁴.

Further evidence that disulphide-bond breakdown is the essential cause of unshrinkability has now been obtained by comparing the action of chlorine, sulphuryl chloride and sodium hydroxide on untreated wool and wool in which some of the disulphide bonds are replaced by more resistant cross-linkages. The most simple method of preparing wool containing a large number of stabilized cross-linkages is by treatment with dilute sodium hydroxide solution in the cold for several hours. Some of the disulphide bonds are thereby replaced by $-\text{CH}_2-\text{S}-\text{CH}-$ ⁵ and $-\text{CH}=\text{N}-$ ⁶ cross-linkages, the presence of which is indicated by the fact that fibres (human hair) immersed in 0.1 *N* sodium hydroxide solution for six hours or more at 22–23° C. are incapable of supercontraction in boiling sodium bisulphite solution, whereas corresponding untreated fibres contract 23.8 per cent under similar conditions.

For the purpose of these experiments, therefore, two 2.5-gm. patterns of an all-wool flannel were immersed in 2 litres of 0.1 *N* sodium hydroxide solution for 10 hours at 22–23° C., the solution being renewed after the first five hours to prevent undue accumulation of sodium sulphide. After being washed in running water overnight, one of the patterns was removed and treated with 4 per cent chlorine (on the weight of the wool) in a buffer solution at pH 4. The fabric was then treated with 1 per cent sodium bisulphite solution, neutralized with 0.5 per cent sodium bicarbonate solution, and finally washed in running water overnight. An untreated pattern of flannel was chlorinated in the same way, and the three patterns, with a sample of untreated flannel, were milled together by hand in 5 per cent soap solution. The resulting shrinkages are given in the accompanying table, which includes corresponding data for 2.5-gm. patterns treated either for 1 hour at 22–23° C. with 100 c.c. of a 2.5 per cent (v/v) solution of sulphuryl chloride in carbon tetrachloride, or for three hours at 22–23° C. with 10 c.c. of a 7 per cent solution of sodium hydroxide in butyl alcohol made up to 100 c.c. with white spirit.

Treatment	Percentage shrinkage in area of patterns treated with 0.1 <i>N</i> sodium hydroxide for	
	10 hours	24 hours
Untreated	30.6	31.7
Chlorinated	9.2	4.3
Sodium hydroxide	26.4	27.5
Sodium hydroxide and chlorinated	20.7	18.0
Untreated	30.8	32.6
Sulphuryl chloride	5.9	–0.9
Sodium hydroxide	27.1	26.8
Sodium hydroxide and sulphuryl chloride	26.8	13.0
Untreated	36.3	37.9
Sodium hydroxide dispersion	5.1	3.5
Sodium hydroxide	23.1	27.7
Sodium hydroxide and the sodium hydroxide dispersion	15.6	24.4

A second series of experiments was carried out with patterns which had been treated with 0.1 *N* sodium hydroxide solution for 24 hours at 22–23° C. with renewal of the solution after ten hours treatment. In all cases, the shrinkages are based on the wetted out areas of the patterns immediately before milling.

The ability of the fabric to acquire an unshrinkable finish is reduced very considerably by previous treatment with 0.1 *N* sodium hydroxide solution even though all the disulphide bonds of the wool are not converted into more resistant cross-linkages must, therefore, be concluded that disulphide-bond breakdown is the main, if not the only, cause of the unshrinkability imparted to wool by chlorine, sulphuryl chloride and sodium hydroxide. These results have the further importance of revealing the strict control of those operations in which wool is exposed to the action of alkalis, notably in scouring, essential if satisfactory and reproducible results are to be obtained in practice with the above reagents.

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The Food Finding of Wireworms (*Agriotes* spp.)

THE apparent efficiency with which wireworm (*Agriotes obscurus*, *lineatus* and *sputator*), when in a active feeding phase, find crop plants on which to feed is very striking. It is displayed even though these plants may not be particularly closely spaced and at first occupy only a very small proportion of the total soil surface. This makes it appear improbable that random wandering either on or in the soil could offer a complete explanation. Yet in spite of this, and of the enormous literature on wireworm there seem to be no studies on record which throw any clear light on the methods by which the food is found. The potential importance of such knowledge as a basis for the elaboration of trapping methods needs no emphasis, and it was largely for this reason that the work here described was undertaken. It is hoped that the first paper dealing with these investigations will shortly be in the press. The object of this letter is to summarize certain broad conclusions which have so far emerged.

It is now well established (see D. S. Falconer) that wireworms under suitable conditions of temperature and humidity will come up to wander on the surface of the soil. Accordingly, preliminary investigations with olfactometers of various types were made. No evidence was found that wireworms are capable of orientating themselves to the airborne odours of favoured food plants. This being so, work proceeded on the assumption that wireworms can orientate themselves in the soil by means of some substance or substances emanating from plant roots or other tissues and dissolved in the soil water.

Responses of wireworms in the soil were investigated by means of two types of apparatus, one which tests

the biting reaction and the other a soil choice chamber which tests the ability of the animals to aggregate in solutions or suspensions of test substances in sand or soil. In the first apparatus the number of bite marks on a series of baited filter papers, compared with those on a control set exposed simultaneously, gives a numerical measure of the biting response to a given substance or extract. In the second apparatus the figure obtained is the number of wireworms aggregating in a given time under constant temperature conditions in one of the compartments of the choice chamber. All the aggregation tests mentioned in the present communication were carried out in sand. By means of these methods it was first shown that extracts of potato, carrot, beet and other food plants will cause wireworms to aggregate or to bite or both. *A. lineatus* and *A. obscurus* cannot be distinguished in the larval stages; but no differences have yet been found between the responses of these species and those of *A. sputator*.

Aggregation and biting are apparently distinct responses and are elicited by different classes of chemical substances as follows. Biting is elicited by sugars, fats and polypeptides and also to some extent by tannin and polyhydric alcohols. If one gram of a substance is dissolved in x c.c. of water to reach the threshold of either biting or aggregation, then the 'activity' of that substance is defined as $\log_{10} x$. The activity of sucrose was found to be 2. The number of bites made on a given area of filter paper soaked in 2 per cent glucose formed a roughly normal curve when plotted against pH. The maximum (40 wireworms, 24 hours, 23° C) was approximately 1,000 at pH 6-8, falling to 0 at pH 0 and 14. The threshold was not affected by pH.

Aggregation was first studied by observing the response of wireworms to pure sugars. The sugars examined were found to have an activity of 2, the same as that for biting. The aggregation reaction to a plant extract was analysed in the following way. Potatoes were ground and the juice pressed out, spun to remove starch grains and filtered through kieselguhr. The activity of this juice was 6. The sugars in the juice, found to be 1 per cent, would only account for an activity of 0 on a logarithmic scale, so that some other active substance or substances must have been present. After boiling and filtering, followed by boiling with 2.5 per cent of charcoal, a colourless protein-free solution of activity 6 was obtained. The addition of two volumes of alcohol gave a copious inactive precipitate, and a third volume precipitated colourless rhombic active crystals. These proved to be asparagine, which has an activity of 9. Glutamine has the same activity. The distribution of asparagine and glutamine in potatoes has been examined by A. Neuberger and F. Sanger². The means of their results in six varieties are respectively 0.26 per cent and 0.21 per cent of the fresh weight. This range would account for our observed activity of the juice, whether the activities of asparagine and glutamine are additive or not. Aggregation is also caused by a variety of compounds related to asparagine, including aspartic acid 11 and malic acid 9. The lower fatty acids were found to be inactive but their amides are active.

The activity of all active substances falls suddenly to zero below the threshold concentration, above which there was no detectable response to a gradient. While sugars cause both reactions, some other active substances elicit only one of the responses, thus asparagine does not cause biting, nor triolein nor

casein aggregation. There must therefore be at least two types of chemo-receptor, the stimulation of one of which leads to aggregation, and of the other to biting. The sensitivity of the former is comparable to that of olfactory receptors, for an activity of 11 means that the wireworms respond to a concentration of 1 in 10^{11} , while the sensitivity of the latter is similar to that found in organs of taste.

The finding of food by wireworms when in friable soil is probably in the main kinokinetic. This may be envisaged as follows. Wireworms show vertical movements in the soil governed by such factors as moisture content, temperature and season. In addition to this, when in an active feeding phase, they also wander at random in the soil. This may carry them into a region where active substances of plant origin are present in the soil moisture in quantity above the threshold. Their behaviour remains unaffected until they pass out of this region, when they show increased turning movements which would bring them back into it again—upon which they once more proceed through it. By this means they are kept within the favourable region, where their wandering continues until some substance which releases the biting response is encountered and feeding begins. This method of orientation, or something very similar to it, is well known for a number of invertebrates (Ulyott³, Fraenkel and Gunn⁴), but so far as we are aware, this is the first instance in which it has been shown to operate in the food-finding of a soil-dwelling animal. The efficiency of the method in soil will, of course, depend on several factors which are now being studied, such as the rate of secretion of active substances by plant roots, the rate of their bacterial decomposition, the extent to which they are adsorbed on the soil particles, the texture of the soil and the magnitude of the water movements within the soil.

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Periodic Spawning of 'Palolo' Worms in Pacific Waters

THE Mbalolo, *Eunice viridia*, is a marine annelid found in several places in islands of the Western Pacific. In Fiji I know of two and have heard of a third place in which the periodic 'rising' takes place. One such spot is between the shore and the fringing reef at the village of Tokou, in the island of Ovalau.

Another is in the Yasawa islands off the north-west coast of Viti Levu, and I have heard that there are one or more spots in the Lau group, which forms the eastern limits of the Fiji Islands. It also occurs in the Samoan group, where it is known as Palolo; and probably elsewhere.

During my period as commissioner, stationed at Levuka, I have seen the 'rising' at Tokou on several occasions. Nearly every year there are two risings,

the first known as *Mbalolo lailai* (small Mbalolo) and the second as *Mbalolo levu* (large Mbalolo), 'large' and 'small' do not refer to the size of the worm but to the quantity of the worms. Occasionally there is no *Mbalolo lailai*.

In a normal year the *Mbalolo lailai* appears about the end of October and is followed by the second, and main, rising about two or three weeks later. The main rising always occurs at dawn, and, literally, the worm comes up with the sun. It is, also, always at the time of high water.

The worm, when it comes to the surface, is headless, and it is known that the head remains alive in the reef. The parts shed are from ten to fifteen inches long when they reach the top of the water and continue to wriggle.

There was an old Fijian living in the village of Tokou who was a foreteller of the day of rising, and I used to apply to him for information as to when I should take part in the event. To do so required some preparations: a boat and crew with dip-nets ready at the village; somewhere to sleep until about 04.00, when one had to prepare to move out, lanterns, torches and so forth. The information obtained from the prophet was not always reliable. On the other hand, my experience was that when he said he was certain, it was so.

The uncertainty occurred when the usual date—connected with the phases of the moon, no doubt—had gradually got further and further from the normal. Whatever the actual explanation of the date of spawning, the fact remains that the Mbalolo makes its annual rising at an approximate date by the calendar year but at an actual date by the moon and tide. When the difference becomes more than a few weeks, the date combines solar influence and the appropriate lunar and tide conditions. Records have been kept in Levuka, Fiji, for some seventy years, but I have not yet been able to have access to them.

To attend a 'rising' is an unforgettable event. With the necessary preparations made, I have boarded my boat at 04.30 after a sleep in the village and paddled out to a position about half-way out to the main reef, which skirts the shore at this spot at a distance of about a mile. Then torches are shone into the water vertically from the boat's side to see if there are any indications. If it is the right day, small stray bits of the worm make their appearance, and nets are got ready. Then, when the first light of dawn appears, great funnels of worms burst to the surface and spread out until the whole area is a wriggling mass of them, brown and green in colour.

When the tropical sun rises perpendicularly from the sea the catch is in full swing, and hundreds of boats, canoes and punts are filling up kerosene tins and jars by the simple process of dipping them out with nets.

The worms also provide an annual feast for the fish, for all round and between the boats big fish and sharks cruise quietly along, gulping them in, and take no notice whatever of the boats or their occupants.

As the sun makes itself felt, a change begins to occur in the length of the worms. They begin to break up into shorter and shorter bits, until some three hours after sunrise the entire surface of the sea shows nothing more than patches of scum.

Mbalolo is rightly prized as very good eating and, if one can forget what it looks like before being

cooked, is delicious. Fijians—and I have known Europeans to do likewise—eat some raw, when perhaps it may resemble oyster. I could never bring myself to try. In its raw state it is said to have a stimulating effect on fecundity. The Fijians also say that a dish of it eaten in any form will protect a person from all sickness until the Christmas Day following.

A curious fact is that all fish caught in the neighbourhood of the rising are poisonous to human beings for about ten days or a fortnight after the event.

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The C₂₀ Unsaturated Acids of Animal Fats

ESTER-FRACTIONATION analysis of certain animal depot and milk fats has shown the presence of small amounts (1–3 per cent) of unsaturated C₂₀ acids¹. These acids have generally been regarded as highly unsaturated^{2,3} and probably similar to the corresponding liver glyceride fatty acids. Experimental difficulties in purifying the residual ester-fractions (in which the C₂₀ acids accumulate, along with polymerized or partially oxidized acids) have prevented more exact identification.

The amount of C₂₀ acids determined from the polybromide number is, however, usually much less than the amount of C₂₀ acids calculated from the saponification equivalent⁴. Recent work suggests that highly unsaturated acids constitute only a small part of the C₂₀ unsaturated acids. Cramer and Brown⁵, by crystallization of a C₂₀ concentrate, provided evidence for the presence of C₂₀ acids of lesser unsaturation than arachidonic acid in human depot fat. Baldwin and Longenecker⁶ used the isomerization technique of Mitchell *et al.*⁷ to indicate that human milk fat contains 2–5 per cent of an eicosadienoic acid.

In a communication to the *Analyst* not yet available here, we have presented evidence that the C₂₀ unsaturated acids of the depot fat from pigs fattened solely on skim milk largely consist of acids with less than three double bonds. This conclusion has been confirmed by examination of 4 kgm. of pig back fat. The C₂₀ ester fractions consistently retained about 15 per cent of C₁₈ unsaturated esters after repeated fractionation in a highly efficient column. Isomerization by treatment with caustic potash in ethylene glycol and spectroscopic examination of the resulting soaps (using the method of Mitchell *et al.* (*loc cit.*)) and the constants given by Kraybill and Beadle⁸) confirmed the presence in these fractions of an eicosadienoic acid (about 0.2 per cent of the total fat), with smaller amounts of eicosatetraenoic acid.

Crystallization of 25 gm. of the C₂₀ unsaturated acids yielded 10 gm. of acids, in which isomerization did not reveal more than 5.4 per cent of di- and polyethenoid acids. From the saponification equivalent (306) and the iodine value (87.9), it may be concluded that this fraction is mainly eicosenoic acid (saponification equivalent 310, iodine value 81.9).

The C₂₀ unsaturated acids of pig depot fat have been thought to be derived from the diet^{2,9}, but until the corresponding food fats have been examined for eicosenoic and eicosadienoic acids, the origin of these acids remains uncertain. The analyses recorded

by Hilditch and co-workers for cow milk fat^{3,10} are not, however, inconsistent (as judged by saponification equivalents and iodine values of residual ester fractions) with the presence of one or both of these acids in this fat. Indeed, Bosworth and co-workers^{11,12} tentatively claimed the presence of these acids in cow milk fat, a claim which seems to have been neglected by subsequent investigators.

Linoleic, linolenic and arachidonic acids are known to be essential in the nutrition of rats^{13,14}. The possibility of the physiological importance of eicosadienoic acid is of great interest. Work on the constitution of these acids is in progress.

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Effect of Hydrogen Ion Concentration on Cation Exchange in Clay Salts

THE lyotrope series is usually observed in the exchange of cations from clays and permutites^{1,2}. Deviations from this series have also been reported^{3,4}. These have been attributed to the structural peculiarities of the clays^{2,3} and variations in the hydration of cations⁴. Differences in the relative effects of Ba⁺⁺ and Ca⁺⁺ ions in the interaction of hydrogen clays with neutral salts and bases have been observed^{5,6,7}, depending on the prevailing pH of the system. Symmetry values⁸ of a number of clay salts against various electrolytes (chlorides) have been measured with and without adjustment of the pH of the system at a constant value by the addition of the requisite amount of hydrochloric acid. When a constant pH is not maintained, deviations from the normal lyotrope series often occur, especially in clays containing montmorillonite as judged from X-ray analysis. The deviations disappear when the symmetry values measured at a constant pH ranging from 6.0 to 7.0 are compared. At a constant pH between 3.0 and 5.0, all the cations examined give the same symmetry value, and the cation effect as envisaged in the lyotrope series altogether disappears.

At a low pH (3.0), hydrochloric acid alone gives a higher symmetry value than when used in conjunction with the salts. Al⁺⁺⁺ ions are likely to be exchanged at this pH for the cations of the added salt⁹. No appreciable exchange of aluminum at this pH would occur if hydrochloric acid alone were added¹⁰. The lower symmetry value observed in the presence of salts can be explained if one takes into

account the Al⁺⁺⁺ ions exchanged for the cation of the salt.

Further work is in progress.

This work has been carried out with the aid of a grant from the Imperial Council of Agricultural Research, India.

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A Labour-saving Method of Sampling

If a fraction p of a population have the attribute A , then it is well known that if m members out of a sample of N have this attribute, the best estimate of

p is $\frac{m}{N}$, and its standard error is $\sqrt{\frac{m(N-m)}{N^3}}$ or

$p\sqrt{\frac{1-p}{m}}$. Supposing, therefore, that we want our

estimate of p to be correct within a standard error of 10 per cent of its value, we must count a sample containing $100(1-p)$ members with the attribute A . If we do not know p roughly beforehand we do not know how large to take our sample. For example, if we wish to estimate the frequency of a type of blood corpuscle, and count 1,000 blood corpuscles in all, we should get such values as 20 ± 1.3 per cent, or 1 ± 0.31 per cent. The former value would be needlessly precise for many purposes. The latter would not differ significantly from an estimate of 2 per cent.

The standard error is almost proportional to the estimated frequency if we continue sampling until a fixed number m of the minority with attribute A have been counted, and then stop. Supposing the total number in the sample is now N , we cannot use

$\frac{m}{N}$ as an estimate of p . It can, however, be shown

that $\frac{m-1}{N-1}$ is an unbiased estimate of p , with

standard error very approximately $\frac{1}{N}\sqrt{\frac{m(N-m)}{N-1}}$,

or $p\sqrt{\frac{1-p}{m-2}}$, which is nearly proportional to p

when this is small. Thus to get a standard error of about 10 per cent of the estimate we should have to count until we had observed a number m of the rarer type A , which only varies from 102 when p is very small, to 72 when it reaches 30 per cent. If we were content with a standard error of $0.2p$ we could take a quarter of this value, and so on.

My friend, Dr R. A. M. Case, has for some time employed a method substantially equivalent to the above in his haematological work, and found it to result in a considerable saving of labour.

Full details will be published elsewhere

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Adsorption Colorimetry as an Analytical Technique

ADSORPTION of coloured substances on white adsorbents has hitherto been used either to demonstrate qualitatively the existence of the substance in a mixture or as a preliminary to elution in the quantitative assay of the substance

In devising a simple method for the quantitative estimation of mepacrine (atabrin) in urine, a technique has been adopted which I have called 'adsorption colorimetry'. When a measured quantity of suitable white adsorbent is used, the intensity of colour produced under standard conditions is proportional to the quantity of mepacrine in the urine or in an extract of the urine. The adsorbent may easily, and with sufficient accuracy, be measured with a small scoop made by drilling a hole into a piece of wood and calibrating with a powder of known specific gravity. For mepacrine, the most satisfactory adsorbent is powdered silica gel. This may be used either directly, by adding a measured quantity to a known volume of urine for a given time, or indirectly, by adding it to an ether or chloroform extract of alkalinized urine. In this way, it is possible to estimate concentrations as low as 1 mgm. per litre or less, with the common concentrations of 5 mgm. per litre or more, the error is less than 20 per cent.

This technique may obviously be extended to the estimation or detection of other coloured substances. Again, with silica gel, it has been found possible to detect bile pigments in urine in concentrations lower than those detected by the iodine or Gmelin tests, the technique is much simpler than, and the sensitivity about equal to, the Fouchet or similar adsorption methods.

Other coloured substances not adsorbed by silica gel may be adsorbed by other powders. For example, riboflavin is adsorbed by a white preparation of fuller's earth, and preliminary tests indicate that with this adsorbent an adaptation of the method of adsorption colorimetry should be capable of assaying rapidly and with reasonable accuracy and sensitivity the riboflavin content of substances of biological interest.

With fluorescent substances such as mepacrine, the sensitivity of the method may be increased one hundredfold by 'adsorption fluorimetry', that is, by viewing the adsorbent in ultra-violet light. This should make it possible to evolve a method for the estimation of mepacrine in blood, in which the concentration is much lower than that in the urine.

Details of the technique as applied to the estimation of urinary mepacrine and to the detection of bile pigments in urine will be published elsewhere.

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Structure of Stipitatic Acid

Birkmshaw, Chambers and Raistrick¹ have described stipitatic acid, a metabolite of the mould *Penicillium stipitatum*, to which, after lengthy examination, they could ascribe no reasonable structure. The evidence they give, however, does seem to indicate a unique structure for the compound. The evidence is as follows:

(1) Stipitatic acid (*A*), $C_8H_6O_5$, is a dibasic acid, solutions of the disodium salt of which are deep yellow. It contains three active hydrogen atoms and gives a deep red ferric chloride reaction. It has no ketonic or reducing properties and is optically inactive. It dissolves unchanged in concentrated hydrochloric or nitric acid, being precipitated on dilution. (*A*) itself is cream coloured.

(2) (*A*) is unchanged by bromine in acetic acid, in water it forms a loose addition compound. In 80 per cent acetic acid a monobromostipitatic acid is formed, similar to (*A*) in its properties.

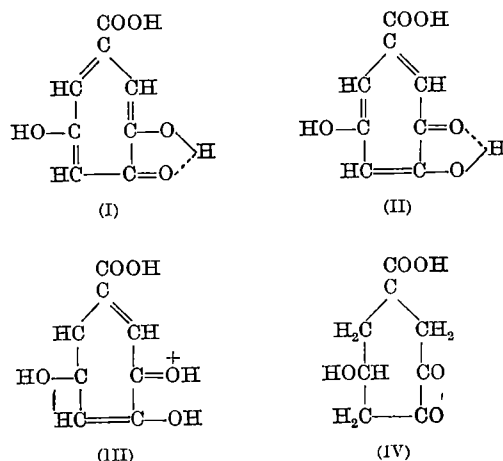
(3) (*A*) is easily converted by alkali fusion to the isomeric 5-hydroxyisophthalic acid, in very good yield.

(4) With diazomethane in ether, (*A*) gives two isomeric, neutral, trimethyl derivatives. With methanolic hydrogen chloride it gives a dimethyl derivative, soluble in sodium hydroxide, but not sodium bicarbonate, solutions. With methyl sulphate and alkali it forms a dibasic monomethyl derivative the disodium salt of which is deep yellow in solution.

(5) With acetic anhydride and sodium acetate, (*A*) forms a monobasic diacetyl derivative, an isomeric but dibasic compound is formed with acetic anhydride and sulphuric acid.

(6) Decarboxylation of (*A*) with copper in quinoline gives a monobasic acid $C_7H_4O_3$, solutions of the salts of which are deep yellow, it gives a blood-red ferric chloride reaction and with diazomethane a neutral dimethyl derivative.

(7) Catalytic reduction over platinum oxide gives a crude non-aldehydic product with half the acid equivalent of (*A*), from it tetrahydrostipitatic acid can be isolated as its dinitrophenylhydrazone.



The stability of (*A*), particularly to bromine (2), indicates the presence of an aromatic structure, bridged ring structures are thus eliminated from steric considerations. Benzenoid or oxygen-ring structures do not explain the very facile conversion to hydroxyisophthalic acid (3). There remains a seven-membered ring structure in which an α -di-

stone group will provide the second acid function and undergo benzoic acid rearrangement on alkali fusion. When the appropriate triketocycloheptene-carboxylic acid is written in the dienol forms (I) and (II), the possibility of resonance between them by hydrogen bond chelation becomes evident, such a compound would be expected to show abnormal solubility and lack of ketonic function. Moreover, the ketol group, from analogy with β -diketones, should show acidity, and the resonating ion, colour. The solubility in strong acid to a hybrid of (III) and its tautomer parallels the analogous behaviour of indophenol. The ready decarboxylation of (4) and the properties of the product are at once explained. Tetrahydrostipitatic acid (7) is probably (V), cyclic α -diketones often give monoketonic derivatives.

The isomeric trimethyl derivatives (4) correspond to (I) and (II), in the dimethyl derivative, where the ketol and ester groups are esterified, the enolic hydroxyl is still weakly acidic. In the monomethyl derivative the lone hydroxyl is methylated (cf the methylation of hydroxybenzoic acids).

The monobasic diacetyl derivative (5) will have the two hydroxyls protected, while the isomeric diacidic compound is presumably a nuclear acylated monoacetate, phenols are sometimes acetylated in the nucleus by acetic anhydride-sulphuric acid.

If stipitatic acid actually has the resonating structure (I) or (II), it represents a new type of aromatic system, the parent cycloheptatrienolone might be termed 'tropolone'. This system would be closely analogous to azulene, while the hydrogen chelation as part of an aromatic system has long been known in the porphyrins. Cyclopentadienolone may prove to have an analogous structure. An attempt to synthesize an analogue of (I) with the carboxyl replaced by methyl, by condensation of mesityl oxide with ethyl oxalate in presence of two moles of potassium ethoxide in boiling ether, unfortunately gave the isomeric benzene derivative.

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Biochem J., 38, 242 (1942)

Preparation of Thin Sections of Synthetic Resins and Wood-Resin Composites, and a New Macerating Method for Wood

VARIOUS softening methods have been used in preparing sections of hard material for microscopic examination, but none of these has been found effective for so-called 'improved wood' made up of wood veneers impregnated with phenol-formaldehyde or other resin and compressed and bonded at a high temperature. The microscopic examination of synthetic resins and materials incorporating such resins is of value in revealing the nature and distribution of fillers, colouring matter and reinforcements, and other features of the internal structure. It has also been found useful as a means of identifying the different kinds of resin used as adhesives in plywood¹. In order to prepare microscope sections of the harder forms of these materials, some investigators have had recourse to the petrologists' method of grinding and polishing thin sections for examination by transmitted light, and the metallurgists' method of examining a polished surface by reflected light.

It has now been found that a mixture of 1 part by volume of glacial acetic acid with 2 parts by volume of hydrogen peroxide (20 volumes) at 60°C and atmospheric pressure has a softening action on fully cured phenol-formaldehyde and urea-formaldehyde resins and on wood-resin composites. After being treated in this way for periods of 24-48 hours, solid blocks of resin and of various types of 'improved wood', up to $\frac{1}{2}$ in cube, have been sectioned without difficulty in a Reichert sledge-type wood microtome.

A modification of this treatment, using equal parts by volume of glacial acetic acid and hydrogen peroxide at 60°C. for 48 hours, has the effect of decomposing or disintegrating urea-formaldehyde resin. Phenol-formaldehyde resins are softened to the extent that 'improved wood' incorporating such resins is broken down and the wood itself is macerated. Incidentally, this method has certain advantages over standard methods of macerating ordinary wood for microscopic examination.

It is known that acetic acid in the presence of oxidizing agents has a delignifying action on wood², but this process does not appear to have been employed before in microscopic technique either for wood, resin or composite materials.

The effect of varying the proportions of the two reagents and the temperature and pressure during the reaction is being investigated further.

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¹ Rendle, B. J. and Franklin, G. L., *J. Soc. Chem. Ind.*, 62, 11 (1943).
² Wiltshire, W. A., *Proc. Papermfrs' Assoc. G. B. I., Tech. Sect.*, 24, 347 (1943).

Age of the Baker's Hole 'Coombe Rock', Northfleet, Kent

SINCE the Abbé Breuil published his view¹ that the palaeolithic 'floor' at Baker's Hole, Northfleet, belongs to the Levallois I-II stage of his classification, some Pleistocene workers² have been inclined to follow him in correlating the superincumbent Coombe Rock with the cold phase which produced the *Rissien* solifluxion of the Somme succession.

The stratigraphical evidence at Baker's Hole is that an undisturbed 'floor' of implements rests on a bench at about 30 ft above O.D. (which is elsewhere buried by 50-ft Terrace deposits), and is directly succeeded by the Coombe Rock^{3,4}. The precise position which we assigned to this deposit in our suggested Thames sequence⁵ depended partly on the identification of the 'floor' as Lower Levalloisian. The fact that the Lower Crayford Brickearths of the 50-ft Terrace have yielded an industry identified by Breuil⁶ as Middle Levalloisian (Levallois III), together with the evidence published by Burchell³, led us to the conclusion that the Coombe Rock antedated the Taplow-Crayford aggradation, and corresponded to the apparent Coombe rock below the 50-ft Terrace gravels exposed in the Taplow Station pit⁷.

One of us (K. P. O.) has recently had occasion to handle all the material found by F. C. J. Spurrell in the part of the Northfleet 'floor' which was exposed in the Tramway Cutting west of the Ebbsfleet, and now preserved in the Geology Department, British Museum (Natural History). A number of features of this industry, including the occurrence of cordate hand-axes along with the tortoise-cores and flakes

with faceted butts, suggest that it should be compared, not with Levallois I-II of the Somme cultural sequence⁸, but with Breuil's Levallois V⁹. It is particularly noteworthy in this connexion that one of the hand-axes is clearly a bifacially trimmed Levalloisian flake.

Mr A. D. Lacaille, of the Wellcome Research Institute, informs us that on the basis of the material from the Northfleet 'floor' which he has seen in Spurrell's collection, he fully supports a revised identification of the industry. There are several possibilities¹⁰, but if the Northfleet industry is early Upper Levalloisian, rather than Lower Levalloisian, the "Baker's Hole Coombe Rock", or at any rate that part which is found in the Tramway section, must be considered as representing a later period of solifluxion than that which Breuil equates with the Riss glaciation.

Since several stages of the Levalloisian culture appear to have coincided with conditions conducive to the formation of solifluxion deposits, it is to be expected that difficulty will be experienced in dating sheets of coombe rock which happen to be associated with incompletely defined industries of the Levalloisian complex. For this reason we feel that a caveat should be entered regarding the age of the main solifluxion deposit in the Northfleet district, pending fuller elucidation of the Levalloisian complex in south Britain. We wish also to emphasize that any revised dating of the Northfleet industry does not necessarily involve so-called Northfleet types from other sites (for example, Brundon¹¹) which may well be Lower Levalloisian.

The Levalloisian cores and implements collected by Spurrell¹² at the base of the Crayford Brickearth have also been seen. The evidence for their being Middle Levalloisian, rather than, say, a provincial facies of Upper Levalloisian, cannot be said to be absolutely conclusive in the present state of our knowledge of the British Levalloisian succession. Until the question of whether they are younger or older than the Northfleet industry is settled beyond all dispute, the stratigraphical implications of revised dating of the latter cannot be very usefully considered. Clearly, however, the possibility has to be borne in mind meanwhile that the Baker's Hole Coombe Rock post-dates at least part of the Crayford Series.

It is hoped that the whole matter can be gone into more fully when the sections can be re-visited and when all the collections of material from Northfleet and Crayford can be re-examined and compared.

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¹ *Geol Mag*, 17 (1932)

² Oakley, *Quartär*, 2, 56 (1939). Paterson, *Trans Roy Soc Edin*, 80, 408 (1940-41)

³ Smith, *Archaeologia*, 62, 515 (1911). Burchell, *Archaeologia*, 83, 67 (1933)

⁴ Breuil, *Rev Géog Phys et Géol Dyn*, 7, 269ff, Fig 43 (1934)

⁵ *Proc Prehist Soc*, 2, 61 (1930)

⁶ *Geol Mag*, 17 (1932)

⁷ Breuil, *op cit*, Fig 41

⁸ Breuil and Kowalski, *L'Anthropologie*, 42, 44, Fig 15 (1932)

⁹ *Ibid.*, 33, Fig 6, No 1, 36, Fig 9, Nos 2 and 4

¹⁰ *Trans S E Union Sci Soc*, 48, 31 (1943)

¹¹ Moir, *Proc Prehist Soc*, 5, 5 (1939)

¹² *Quart J Geol Soc*, 38, 544 (1880). Cf Chandler, *Proc Prehist Soc E Anglia*, 2, 240 (1916). Kennard, *Proc Geol Assoc*, 55, 139 (1944)

Distribution of Numbers and Distribution of Significant Figures

In an earlier note¹ it is shown that the distribution of first digits of the numbers in a table will obey a logarithmic law provided that a certain sum can be replaced by an integral. We shall here discuss this approximation in more detail. The notation used will be the same as before, $f(x)$ giving the distribution of the numbers and $F(p)$ the distribution of the significant figures. We shall also introduce the distribution of the logarithms of the numbers, setting $y = \ln x$, we have for the fraction of entries with logarithms between y and $y + dy$

$$\varphi(y) dy = e^y f(e^y) dy = f(x) dx; \quad (1)$$

$$\int_{-\infty}^{\infty} \varphi(y) dy = 1 \quad (2)$$

We then have, by equation (5) of the preceding note,

$$F(p) = \frac{1}{p \ln A} \psi(\log_A p), \quad (3)$$

where

$$\psi(q) = \sum_{m=-\infty}^{\infty} f(A^{m+q}) A^{m+q} \ln A = \sum_{m=-\infty}^{\infty} \varphi(m+q) \ln A \quad (4)$$

Thus $\psi(q)$ is the approximation to the integral in (3) by the trapezoidal rule, the spacing of the selected ordinates is $\ln A$, and their position is determined by q . We see that

$$\psi(q+1) = \psi(q), \quad (5)$$

so that it suffices to consider values of q between zero and unity, no other values would be required for use in (3), anyhow. Also

$$\int_0^1 \psi(q) dq = 1, \quad (6)$$

and

$$\text{if } x f(x) = \frac{1}{x} f\left(\frac{1}{x}\right), \text{ then } \psi(q) = \psi(-q) \quad (7)$$

When applicable, this last relation is very helpful in determining ψ by computation.

If $\psi(q)$ were identically equal to 1, the logarithmic law would hold exactly. Functions $\varphi(y)$ for which this is true for a particular base A can readily be constructed, but it seems evident that no function can satisfy this condition for arbitrary A .

The idea that the broadness of the distribution essentially determines the closeness with which $\psi \equiv 1$ needs careful examination. If we make the distribution $f(x)$ broader by a factor α , by replacing it with

the distribution $\frac{1}{\alpha} f\left(\frac{x}{\alpha}\right)$, we find that the maximum

value of $|\psi - 1|$ is unchanged. The function ψ is simply replaced by

$$\psi_\alpha(q) = \psi(q - \log_A \alpha), \quad (8)$$

the sizes of the errors are unchanged, and they merely occur at different values of q .

Thus the value of $|\psi - 1|_{\max}$ is determined on the value of the function $\frac{1}{\alpha} f\left(\frac{x}{\alpha}\right)$, and not at all by

the value of the scale-factor α . Values of $|\psi - 1|_{\max}$ for $A = 10$ for several distribution functions have been obtained by computing ψ numerically from (4) and are given below. Of these, (b), (c) and (e) are not inconsistent with data obtained from counting

tables, though (b) seems not to fit quite so well as the assumption $\psi \equiv 1$ (logarithmic law)

	Function	$ \psi - 1 _{\max}$ ($A = 10$)
(a)	$\frac{2}{\sqrt{2\pi\alpha}} e^{-x^2/2\alpha^2}$	0.33
(b)	$\frac{2\alpha}{\pi(\alpha^2 + x^2)}$	0.0557
(c)	$\frac{4\alpha}{\pi^2} \cdot \frac{\ln(x/\alpha)}{x^2 - \alpha^2}$	0.00152
(d)	$\frac{1}{\alpha} e^{-x/\alpha}$	0.115
(e)	$\frac{\alpha}{(\alpha + x)^2}$	0.0065

For $A = 100$ the values of $|\psi - 1|_{\max}$ become much larger, 0.24 for (e) and 0.11 for (c), thus (c) alone is not clearly inconsistent with the scanty data from counts on this basis.

Since the accuracy of the approximation $\psi \equiv 1$ is not improved by increasing the scale factor α , we are led to try mixing together distributions of type

$f\left(\frac{x}{\alpha}\right)$ with various values of α . If we assume that in

the final mixture a fraction $\frac{1}{\beta} g\left(\frac{\alpha}{\beta}\right) d\alpha$ of the entries comes from distributions with values of α between α and $d\alpha$, then the fraction between x and $x + dx$ will be $\frac{1}{\beta} h\left(\frac{x}{\beta}\right) dx$, with

$$\frac{1}{\beta} h\left(\frac{x}{\beta}\right) = \int_0^\infty \frac{1}{\alpha} f\left(\frac{x}{\alpha}\right) \frac{1}{\beta} g\left(\frac{\alpha}{\beta}\right) d\alpha \quad (9)$$

If, in particular, $g(x) \equiv f(x)$, then we shall call h the 'iterate' of f . In our table the Cauchy function (b) is the iterate of the Gaussian (a), (c) is the iterate of (b), and (e) is the iterate of (d). It is evident from the table that iteration does rapidly decrease the value of $|\psi - 1|_{\max}$.

The relation (9) of iteration corresponds to the following relation between the distributions $\psi(q)$ connected with f, g, h by formulae of the type of (4)

$$\psi(h)(q) = \int_0^1 dr \quad \psi(g)(r) \psi(f)(q-r) \quad (10)$$

If we represent each distribution $\psi(q)$ by a Fourier series,

$$\psi(q) = \sum_{-\infty}^{\infty} a_n e^{2\pi i n q}, \quad a_{-n} = a_n^*, \quad (11)$$

then (10) gives

$$a_n(h) = a_n(g) a_n(f) \quad (12)$$

In particular, iteration of a distribution function corresponds to squaring each Fourier coefficient a_n . One can show readily that since $\psi(q)$ is nowhere negative, $a_n < 1$ for all n , thus it is evident that iteration repeated a sufficient number of times will make $|\psi - 1|_{\max}$ arbitrarily small. If one assumes that only one harmonic exists—that is, $a_n = 0, n \neq n_0$ —then it can easily be seen that the value of $|\psi - 1|_{\max}$ for the iterate is half the square of the value for the original function. This relation holds within about 1 per cent for the cases given in the table, the appearance of the computed curves of $\psi(q)$ shows that only the first harmonic is important in the cases in hand.

The fact that the close agreement between the trapezoidal sum and the integral in cases like (c) and (e) is not at all to be attributed to broadness of the distribution is seen very forcibly in the process of computing the sums numerically. In all cases

considered, at least two thirds of the sum comes from the largest two terms, and at least seven eighths from the largest three. For three of the sets of ordinates computed for case (c) numerical integrations were performed by Weddle's rule, and the fractional errors found were 0.00612, 0.01224 and 0.01905—four, eight and twelve times the maximum error of the trapezoidal rule for ordinates at the given spacing.

The remarkable affinity between certain functions such as (c) and (e) and the trapezoidal rule enables us to write approximate relations of a peculiar sort. For example, from (e) we get

$$\frac{1}{\ln Z} \approx \frac{1}{4} + 2 \sum_{k=1}^{\infty} \frac{Z^k}{(1 + Z^k)^2}, \quad (13)$$

for Z real and greater than unity but not a large number. This is never exactly true, but the error becomes small very rapidly as Z is decreased. For $Z = 10$, the error is 2/3 per cent, for $Z = 4$, it is 0.004 per cent, and for $Z = 2$, it is not more than about 10⁻⁷ per cent and cannot be determined readily by using an ordinary ten-digit computing machine.

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¹ *Nature*, 154, 800 (1944).

Hissing Sounds Heard During the Flight of Fireballs

MANY responsible eye-witnesses, in their descriptions of fireballs, have emphatically stated that they have occasionally heard a peculiar hissing sound *simultaneously* with the flight of a meteor. From personal observation, I can also testify to the validity of these statements. Fireball literature is full of such accounts. Three recent cases (connected with fireballs seen by a number of competent observers at Hyderabad, on October 13, 1936, on March 25, 1944, and on August 6, 1944, respectively) have placed the matter beyond any doubt whatever.

The obvious difficulty is about the simultaneity of the light and sound phenomena noticed by observers fifty to a hundred miles distant from the meteor. But it must be remembered that the fireball rushes through the upper atmosphere with parabolic speed (about 26 miles per second), its duration of visible flight is generally 6–8 seconds. Assuming its height to be roughly 75 miles, *matter* from a *fragile aerolite* can issue in a regular stream along its entire path, into the lower atmosphere, with velocity large enough to bring it in the vicinity of an observer while the meteor is still in sight. For the height assumed, four or five seconds may suffice (even allowing for air resistance) for the *matter* from the meteor to reach the air in the neighbourhood of the observer, and thus give rise to sounds variously described as like the swish of a whip, the hissing noticed while a cutler sharpens a knife on a grindstone, or a hot iron being plunged into cold water.

A shower of fine sand beating against the leaves of trees was noticed immediately after the apparition of the fireball of October 13, 1936, described in detail in *Science and Culture*, Calcutta, 2, No. 5, 273 (1936).

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RESEARCH ITEMS

Peruvian Pottery

THE gap between the Early Chimú (or Mochica) and Late Chimú pottery has long troubled students of Peruvian archaeology, though Kroeber in particular has made great efforts to indicate the probable characteristics of a Middle Chimú style. Jorge C. Muelle (*Univ. California Pub. Amer. Arch. and Ethnol.*, 39, No. 3, 35 cents) despairs of finding pottery which may bridge the gap, and suggests instead that the Late Chimú pottery developed from metal prototypes, most of which have, for obvious enough reasons, disappeared. He points out many metallic features in the Late Chimú bucchero ware, and illustrates some interesting parallels between pottery and metal forms. The theory is ingenious, but it is difficult to regard it as altogether satisfactory. There are many points of similarity between Early and Late Chimú, and it seems improbable that lost metal forms can be the only link between two cultures so rich in pottery. Until the northern part of the Peruvian coast is more thoroughly explored, the possibility of finding an intermediate pottery style cannot be excluded. In support of his theory, the author makes a suggestion that the heavy stirrup-spouted "coastal Chavin" vessels were derived from metal forms, which were in their turn copied from Early Chimú stirrup spouts. In so doing he disregards the general belief that the coastal Chavin, or Cupisnique, style is earlier than Early Chimú, a belief which recent excavations by Rafael Larco Hoyle have done much to uphold.

Blood Urea Clearance of Indians

THE 'blood urea clearance' is widely used in clinical medicine as a measure of kidney function. The normal standards usually adopted are those of van Slyke for healthy Americans calculated to a standard body area of 1.7 m². The figures are 54 c.c. for the standard clearance and 75 c.c. for the maximum clearance. C. Srikantha and D. Shamanna (*Proc. Ind. Acad. Sci.*, 19, 121, 1944) have found that the corresponding average figures for healthy Indians from the Province of Mysore are 36 c.c. for the standard clearance and 47 c.c. for the maximum clearance. Grokhale (*Ind. J. Med. Res.*, 3, 627, 1941) found very similar figures for Bombay Indians. The figures suggest that the Indian kidney has only about two thirds the efficiency of its American counterpart, but whether this is true or not, it is obvious that a new and lower 'normal' standard will have to be adopted for clinical work on Indians. The first authors suggest that the lower clearance of Indians is related to the lower protein content of their diet.

Utilization of Metabolic Water in Insects

It has often been suggested that insects developing on substances with low water-content such as flour, grain, wool, etc., obtain their necessary water from the products of food combustion. Growth in insects normally living on such dried foods is faster and higher than at low humidities. Experiments were carried out by G. Fraenkel and M. Blewett (*Bull. Entom. Research*, 35, July 1944) with the flour moth *Ephestia kuehniella* and two beetles, namely, *Tribolium confusum* and *Dermestes vulpinus*. It was found that at low humidities more food is eaten to produce a given unit of body weight, because part of the food is utilized as water. As a consequence of this, the

larva grows more slowly and its final size is smaller. It is shown for *Dermestes* at 30 per cent R.H. and *Ephestia* at 1 per cent R.H. that less than 32.9 and 7.6 per cent of the water in the pupae can be derived from water ingested with the food. The authors consider that they have established beyond doubt that the insects in question, which normally live on very dry food, acquire a substantial, or, at extremely low humidities, the greater part of the water ultimately found in the body, from oxidation of food.

Heritable Wildness in Turkeys

In a field study conducted in the Ozark region of Missouri, A. Starker Leopold has endeavoured to assess the ingredients which make up the adaptive condition of wildness in turkeys (*Condor*, 46, 133, 1944). His method was to compare various characteristics of the native wild turkey (*Meleagris gallopavo sylvestris*), of which free populations are notably successful in the Ozarks, with characteristics of hybrid and domesticated turkeys (derived from the Mexican race, *M. g. gallopavo*) the population of which are partially or entirely unsuccessful there. Differences which appear to be directly or indirectly connected with relative wildness and domesticity are described under these heads: (1) wariness and tolerance of disturbance, (2) age of attaining sexual maturity and the related development of secondary sex characters in males, (3) timing of the breeding cycle, (4) behaviour of hens and chicks in response to threatened danger, and the differential behaviour of chicks in the laboratory, (5) extent of moult in young birds, and (6) the relative size of the brain and endocrine glands. The original domestication of *M. g. gallopavo* was probably a gradual selective process by which the genetic constitution of the wild bird was modified to bring about a physiologic adaptation to existence with man, while the wild condition of native turkeys is effectively maintained by a different set of selective factors in a natural environment.

Are Genes Related to Antigens?

A. H. Sturtevant (*Proc. U.S. Nat. Acad. Sci.*, 3, 176, 1944) and Sterling Emerson (*Proc. U.S. Nat. Acad. Sci.*, 30, 179, 1944) have published a most important hypothesis of a relationship between genes and antibodies. It was suggested by Haldane in 1935 that there might be a similar molecular configuration of the antigen to that of the gene which produced it. Hence the antibodies produced in reaction to the antigen might react also with the gene. The classic experiment of Guyer and Smith with the lens of the rabbit would be explained on this new hypothesis as follows. The antibodies to lens protein are free in the circulation of injected rabbits and some combine with the genes in the germ tract which are responsible for the specific lens-antigen. By so combining, the antibodies inactivate the genes, leading to the observed lens deficiency in the progeny. Thus a mutation is produced, but not in a manner analogous to a Lamarckian induction. S. Emerson treated *Neurospora crassa* with antisera from rabbits treated with mycelial filtrates of the fungus. Of 270 controls from untreated cultures crossed with a standard line *N. crassa* cultures nor produced a detectable mutation, among 695 cultures from treated cultures crossed with the standard line there were 25 mutations. The author suggests that the mutations were direct results of reaction between the gene and its specific antibody. The far-reaching

fects of the hypothesis necessitate further experimentation on a large scale. Might it not be valuable to irradiate antibodies and to test their reactions with the originating genes?

Virus Disease of Lupins

D O NORRIS (*Aust Coun Sci and Indus Research Bull* No 170) describes the symptoms of a virus disease upon several species of lupin. The reactions of *L. varius* are peculiar in that the first stage of infection affects the leaves, which become distorted and lighter in colour and develop necrotic areas. In the second stage, which occurs after a resting period of a fortnight or more, a large number of spindle-shaped shoots arise to give a 'bunch-top' closed appearance. The main vector is *Myzus Persicae*, and infection may be carried over the hot dry season on *Cassia corymbosa*, peas, broad beans, and sweet peas. The degree of attack on five species of lupin is inversely correlated with the alkaloid content. This may be due to the unpalatability of high alkaloid plants, but *L. luteus*, low in alkaloid and is less susceptible to this mosaic disease.

Equation of State for Solids

BRADBURN'S equation of state for a solid cubic crystal of identical atoms uses the postulate that the mutual potential energy of a pair of atoms follows a law of the form $\phi = -a_1 r^{-m} + b_1 r^{-n}$. R. Furth (*Proc Roy Soc, A*, 183, 87, 1944) has developed a method for determining the exponents m and n in the force law for a given element from measurements of the sublimation energy, the compressibility, the thermal expansion coefficient, and the dependence of these quantities on pressure and temperature. For many elements the predicted values of compression and thermal expansion are in satisfactory agreement with measurements up to very high pressures and to temperatures near the melting-point. The relation between melting and mechanical instability of the lattice is discussed, and a rule connecting the two phenomena is found to be closely related to Lindemann's law.

A 700-kV D.C. Electrostatic Generator

A PAPER by J. F. Smea (*J Inst Elec Eng*, 91, Pt 1, No 47, November 1944) covers in some detail the construction, development and operation of a Van de Graaff type of electrostatic generator, which was originally designed to give an output of 1 mA at 700 kV, operating at atmospheric pressure. Under certain conditions, however, this current and voltage may be considerably exceeded. Assuming that a machine can be designed *ab initio* for a given output, an allowance must be made for certain factors which cannot be precisely predicted. It appears that in all probability each generator of the Van de Graaff type which differs from others in the details of its design and construction will have its own set of special problems, which must be solved empirically for that particular machine. As the generator was originally intended for research on nuclear physics in a restricted space, the overall dimensions were reduced to a minimum. The main advantages of this type of machine in connexion with acceleration-tube apparatus of any kind are its relative cheapness of construction and maintenance, the ease with which the polarity can be reversed, and its constant current characteristic, the latter being especially valuable in its avoidance of damage to the tube or associated apparatus in the event of accidental short-circuit, failure of vacuum, etc.

Wave Mechanics in Chemistry

In his presidential address to the Chemical Society (*J Chem Soc*, 340, 1944), Dr W. H. Mills pointed out some of the simpler aspects of wave mechanics as they may most usefully be applied to chemical problems. The implications of the exchange integral and the broad theory of resonance are very clearly stated, and a detailed consideration of many actual examples shows that the ground-states of aromatic compounds may be represented as resonance hybrids in which the conventional structure is stabilized by contributions from electromeric modifications. Such matters as aromatic substitution, and the relation of five-membered heterocyclic compounds to the aromatic series, are dealt with in an interesting manner.

Titan's Atmosphere

THE March issue of *Sky and Telescope* has a brief note on Gerald P. Kuiper's discovery in January of the composition of Titan's atmosphere. The same subject is dealt with at greater length by Charles A. Federer, jun., in *Science Service*. It was known several decades ago that Titan had an atmosphere, but the difficulty of obtaining satisfactory spectra prevented any statement regarding its composition. Dr Kuiper, of the McDonald Observatory of the Universities of Chicago and Texas, has photographed its spectra and has shown that it contains methane and ammonia, like Saturn. Although the gravitational pull of this satellite is only about one seventh that of the earth, and hence we should not expect it to retain an atmosphere, yet, owing to its great distance from the sun, it receives only about one per cent of the solar radiation which our moon receives. As a consequence, its temperature is very low, probably about -160°C , and everything except methane must be frozen to the surface of the satellite. It is believed that clouds or droplets of ammonia are suspended in the methane atmosphere of Saturn, and probably the same is true of the atmosphere of Titan. A common origin for the satellite and its primary is indicated by the similarity of their atmospheres, in spite of the fact that the density of Titan is about five times that of Saturn. The low density of Saturn is easily explained, however, by assuming that a great portion of what we see is its atmosphere.

Orbit of Melb 4 AB

W. P. HIRST has given revised elements for the two brighter components of this triple star (*Mon Not Roy Astro Soc*, 103, 6, 1943). These are compared with Voûte's elements, and it is shown that Voûte's eccentricity is too small, 0.551, as contrasted with 0.574 obtained by Hirst. Some of his other elements are also capable of improvement to a small extent. The corrections to all the elements, except the semi-axis major, were based on the angles only. Distances were not used because the earlier ones, especially those used by northern observers, occasionally show large residuals which appear, among certain observers, to be systematic. On the whole, the angle residuals are fairly satisfactory, though, as the table shows, between 1934.21 and 1934.62, there is a run of residuals of the same sign, and these (all by Voûte) have a systematic appearance. There is a long run of distance residuals from 1917.58 to 1928.53, and it is suggested that this is due mainly to low altitude or small aperture.

SIXTH-FORM PHYSICS AND CHEMISTRY

IT is generally agreed that the present standard of the higher school certificate examinations, which serve as a means of selection for State and county major scholarships in addition to their function as tests of a two-year sixth-form course, strains the average candidate. It is also said that they cause even the gifted boy to be cramped by a too early specialization, which reacts unfavourably on his university career and later life, a charge which is made against the open scholarship examinations at Oxford and Cambridge themselves. Some of these effects are noticeable in physics and chemistry, parts of the normal course are too exacting for the boy of moderate ability, while the boy who proceeds to the university is likely to be disappointed and unsettled by the recapitulation during his first year of work already done at school.

The report of the Institute of Physics on the Education and Training of Physicists remarked in 1943 on the economy of time and effort that could be achieved by rationalization of the whole scheme of scholarship and higher school certificate examinations. A first step towards general agreement along these lines has been made by the Cambridge Joint Advisory Committees, which have issued syllabuses* indicating the course of school work on which the Cambridge Higher School Certificate Examination, the Oxford and Cambridge Joint Board Higher Certificate Examination, and the College Scholarship examinations will be based. The Science Masters' Association and the Association of Women Science Teachers were represented on the Committees, which comprised school and university teachers, and representatives were appointed as observers by the Joint Matriculation Board of the Northern Universities and the University of London Matriculation and School Examinations Council.

The syllabuses have been adjusted to the capacity of the average candidate, and designed to avoid overlapping with first-year university work. Scholarship and distinction candidates would offer an optional theoretical paper on each of the syllabuses in addition to the practical examination and two theoretical papers compulsory for all candidates, the practice which has for some years been followed by, for example, the Northern Universities Joint Matriculation Board. It is hoped that this would serve to select scholars without subjecting them to the pressure of unduly advanced work.

The Physics Committee has faced the chief problem of the sixth-form physics class—the 'weak mathematicians' and those whose interests are not primarily mathematical. It is undoubtedly possible for such boys to make good progress in physics up to a certain standard, without being able to do themselves justice in examinations with the present kind of question. They can follow a quite rigorous argument with intelligent resignation, and understand and apply the physical principles concerned, but cannot do mathematical problems of the conventional type. Most teachers will therefore approve of the list of topics, mainly mathematical, and some of acknowledged difficulty to all students (such as the force between the plates of a condenser), on which questions will not be asked.

The usual ground has been extended by including simple radio theory, and appliances such as the cinematograph, gramophone, sound film projector, loud speaker, and cathode ray oscillograph. It should thus no longer be theoretically possible (as it was some years ago) for a boy to leave school, after two years of specializing in science, completely uninstructed in the principles of most of the electric appliances to be met in the outside world.

Experiments of the 'pure practical' type, involving problems on topics not necessarily covered by the theory syllabus, may be set in the practical examination. The boy of outstanding promise should more readily reveal it in this kind of exercise than in the usual routine type of experiment, and a practical course containing a good proportion of these problems has a surprisingly stimulating effect on a class.

In drawing up the chemistry syllabus, the Committee concerned has borne in mind that the study of this subject should be based on experimental work and that a clear understanding of chemical and physical principles, founded on first-hand knowledge is of paramount importance.

In general and inorganic chemistry, importance attached to the gradation in properties of the elements and their compounds, such as hydrides, oxides and halides, this study to be closely linked with the Periodic Table. The Committee stresses that every effort should be made to provide the student with mental picture of the molecular processes involved in the fusion of solids, evaporation of liquids, diffusion, gaseous reactions and chemical equilibria, and that the mathematical treatment of these topics should not be expected.

Most teachers will welcome the decision to delete from the syllabus, limiting densities, the phase rule, ionic mobilities, transport numbers and quantitative problems on solubility products, since experience has shown that these are rather beyond the grasp of the average sixth-form pupil.

In organic chemistry the usual sixth-form syllabus has been pruned considerably. Emphasis is placed on a knowledge of the arrangement of the atoms (excluding stereoisomerism) in the molecules of compounds, and of the typical reactions of characteristic groups, rather than on the preparation of a large number of compounds. The economic aspects of the subject have not been overlooked, and teachers will be glad to see that the cracking of oils, polymerization of olefins, and syntheses from acetylene and carbon monoxide have been included in the syllabus.

In the practical work the Committee recommends that a knowledge of the standard qualitative analytical tables should not be required, but that analysis should be closely linked with the teaching of inorganic chemistry, and that the fundamental principles involved should be clearly understood. The identification of mixtures of salts is limited to three radicals of which no two metals will be in the same group and the phosphate elimination will not be required. The volumetric work is confined to acid, alkali, permanganate, thiosulphate and silver nitrate (neutral solution) titrations, and if problems are involving other reagents, sufficient working details will be given.

The syllabuses do not seem too long for the time allowance of seven or eight forty-minute periods which is proposed for each of the subjects, physics and chemistry, these allowances are more generous than those on which the present arduous courses are covered in some schools.

* Cambridge Joint Advisory Committees. Syllabuses for Examinations taken by Sixth Form Pupils in Physics and Chemistry. Pp. 16 (London: Camb. Univ. Press, 1944.) 6d.

The Committees invite criticism and comment, which will be considered before further editions are issued. No doubt individual teachers will have constructive suggestions to make, and probably the very detailed list of topics for study and omission will be revised from time to time, but the syllabuses as a whole will be widely welcomed, representing as they do a standard which the majority of sixth-form boys could be able to reach.

Teachers and examiners, who have for many years accepted with patience the hitherto untested hypothesis that many of the defects of their students are due to their own excessive zeal, will have another reason for welcoming the new syllabuses. One factor responsible for literary incapacity, narrowness of outlook, and other personal shortcomings, has now been much reduced in magnitude, should these failings still persist appreciably, attention may in future be turned to other factors in the curriculum. The absence of intensive specialization is not enough, a sound general course for the sixth-form science student calls for the best that the human studies can provide, and they now have their chance.

The shifting of emphasis from the 'needs of the lifted few to the needs of the majority still leaves a problem to be faced. The good scholarship boy at present enters the sixth form at the age of fifteen, takes his higher school certificate examination for the first time at sixteen or seventeen, and then (in peace-time) has a year and a term at least in which to compete for awards, proceeding to the university at eighteen or nineteen. With the proposed scheme, it seems likely that boys of scholarship calibre may gain awards at seventeen, which is generally considered too young for entering a university. It would appear undesirable for these boys to spend a further year at school simply marking time with the rest of the class, and anticipation of university work is one of the disadvantages of the present system. It would be valuable indeed if the Committees, in later issues of the syllabuses, could round off an already excellent job by suggesting general syllabuses covering a year's post-higher school certificate work for those who are preparing either to enter a university or start directly on their careers after a final year at school.

AGRICULTURAL EDUCATION ASSOCIATION JUBILEE MEETING

THE Agricultural Education Association celebrated its fiftieth birthday at a luncheon at the Holborn Restaurant, which took place during the annual conference held during December 12 and 13 in London. The principal guest was the Minister of Agriculture, who had with him Sir George Courthorpe, president of the Royal Agricultural Society, Mr Nevill, representing the National Farmers' Union, the United States agricultural attaché, and the chairman of the Horticultural Education Association.

In his address, Mr Hudson said that the Agricultural Education Association has important functions to perform, not the least is the opportunity it affords workers of meeting and getting to know each other. He referred to the legislation which has recently been passed providing for the establishment of a unified National Agricultural Advisory Service,

and defended the decision to separate responsibility for farm institutes from the main scheme. "We want and intend to make this Service one which by its conditions, its opportunities of advancement and its scope will attract to it the most highly qualified men in all its branches", the Minister continued.

Mr Hudson stressed the importance which he attaches to the twin jobs of education and advice for the future of agriculture. The future of the industry will depend upon the ability of the farmer to produce food at prices which will bear a reasonable comparison with the prices at which we can buy food from overseas, to do this, the industry must make use of all the latest scientific discoveries, all the most up-to-date methods that exist in the world and are suitable for British conditions. The farmer is not a person who is able to travel about freely and see and learn things for himself, it must be through the eyes and ears of technical advisers that he will be able to keep abreast of modern developments. Mr Hudson said he is anxious about the great scarcity which exists to-day of good technical men. Men must be found for the Advisory Service, men to teach the older students at the universities and colleges, men to teach the younger students at the farm institutes, men to instruct the large numbers of ex-Servicemen, men to staff the research stations, and so on. Men with an expert agricultural training will also be wanted by commercial firms, by the Colonial Agricultural Service and in other fields. Therefore it might be difficult for a time to push on as rapidly as he would like.

Dr Charles Crowther had previously given an account of the early days of the Association. It was founded in 1894 at the instance of Mr Brooke-Hunt, then the one education inspector of the Board of Agriculture. At first the membership was small, consisting of a handful of heads of agricultural educational institutions and departments. Soon, membership was thrown open to members of staffs, and in 1912 the Association numbered 130. After the War of 1914-18, a great expansion took place, and the present membership is between four and five hundred. After referring to the contributions which the Association has made to experimental work, Dr Crowther said that it has never failed to formulate its views and present them to every commission or Government committee that has reviewed the field of agricultural education during the past fifty years, and the recommendations and subsequent administrative action have shown clearly the potency of the Association's intervention. Dr Crowther concluded with the comment that the more highly specialized agricultural education becomes the greater will be the need for the Agricultural Education Association.

A feature of the programme at this jubilee meeting were the surveys of progress during the past half-century in grassland, livestock and dairying. Very aptly, Sir George Stapledon contributed the review of grassland work. He claimed that permanent grass dominated the outlook at first. Even the pioneer investigations of Somerville, Gilchrist and Elliot were mainly directed towards permanent turf. To Gilchrist, Sir George gave the credit for bringing together the important factors of phosphates, wild white clover, sensible seeds mixtures and the greater needs of the farmer. He paid tribute to the valuable work on the nutritive value of grass carried out by Prof T W Fagan and Dr H E Woodman, saying that if we do not have a clear understanding of the factors influencing the nutritive value of grass we

can have no scientific basis for the proper management of grassland as feed for animals. He praised very highly the pioneer work of Hosier with his milking bails, and went on to say that a two-compartment system of agriculture, based on huge areas in permanent grass and rough grazings, and lesser areas in arable land, affords the minimum of insurance against weathering catastrophe, and makes impossible a virile and adventuring agriculture throughout the country.

Mr James Mackintosh said that the chief change in dairying has been the increase in the demand for milk for liquid consumption. In 1875, Morton estimated that only one third of the milk produced in England and Wales was used for liquid consumption. Rew, in 1892, raised the proportion to two thirds. In 1938, of the total milk production, some 68 per cent was consumed as liquid milk, and in 1943 no less than 90 per cent was directed to the liquid milk market, and only 10 per cent was made into produce. Mr Hudson has now said that another 350 million gallons a year will be needed before rationing of milk can be discontinued. Mr Mackintosh discussed in turn such influences on milk production as the introduction of imported foods, of improved methods of feeding, of modern methods of housing milking cows, of milk recording, and of regulations made by Government and other bodies. This was a comprehensive and very much appreciated review of progress and development.

Prof R G White, dealing with British livestock during the last fifty years, believes that the most obvious advance has been in the control of disease, particularly with regard to sheep. He referred to the influence exerted by the importation of cheap phosphatic fertilizers for grassland, and of cheap feeding stuffs, on livestock, and also on the effect of changed standards of living. He commented on the fact that although Great Britain is a relatively small country, there are a large number of local breeds of sheep and cattle, while he does not see any great need for starting new breeds, he would be sorry if any of the old local breeds disappeared before we obtained much fuller information than we have at present about them and their suitability for their special environments and functions. He, too, spoke of the striking development of milk production, saying that fifty years ago about 20 per cent of our cattle were of the purely beef type and less than 10 per cent of the purely dairy type. Now, he estimates, the figures are 25 per cent purely dairy and 15 per cent purely beef. On the subject of breeding, Prof White said that as regards the immediate major problems of breeding policy we can still do nothing better than follow on the lines of Bakewell, nearly two hundred years ago—ruthless selection, inbreeding, followed by more ruthless selection and progeny testing. We have, however, a great advantage over Bakewell in that we understand to a great extent the effect of inbreeding. We know its value, and we realize the dangers and obstacles which are to be avoided.

A paper by Mr E L Crossley described the way in which spray-dried milk powder, the demand for which in war-time has enormously increased, has been packed so as to stand up to tropical conditions for a much longer period. Specially made tins are exhausted of air after being filled with milk powder, and then supplied with nitrogen gas at a pressure of 2 lb per sq in. The process is simple in theory, but in practice many difficulties have to be overcome,

for the vacuum employed is a low one, and the nitrogen itself must be of at least 99.7 per cent purity. This gas-packing process has extended the keeping quality of full-cream spray-dried milk to seven years in temperate climates and to at least three years in the tropics.

Mr V C Fishwick submitted data from experiments with pigs to show that nutrition during the early life of the piglet has a considerable influence upon the breeding capacity and milk production of the gilt. If she is badly fed during the first twelve weeks of her life, she is liable to develop a short frame and a heavy fore end, and her capacity to produce pigs and milk is liable to be reduced. These conclusions can probably be applied to other farm stock, he suggested that the high price of milk encourages calf rearsers to use little milk and unsuitable calf-rearing substitutes, so that the calves are raised on too low a plane of nutrition, with detrimental results on the animal's capacity to produce milk.

An unusual case of crop failure due to the presence of excess amounts of zinc in the soil was described by Mr F Knowles. A field in Essex had apparently been used as a dump for the disposal of dross from munitions factory operating during the War of 1914-18, and when ploughed up for cropping during the present War, cereals and other crops would not grow. The trouble was traced to large amounts of zinc and copper in the soil, and experiments made in pots and in the field showed that the trouble could be overcome by liming the ground. Prof T Wallace contributed a paper summarizing our present knowledge of mineral deficiencies in soils and crops.

Other papers were read by Mr F H Garner and Dr Dillon Weston on the growing of field beans and on the fungus diseases to which the crop is subject. There was also a useful discussion in the Biology Section on modern methods of pasture evaluation, the principal speakers being Mr William Davies and Mr J Lambert, of the Grassland Improvement Station, Stratford-on-Avon. A small committee was set up to go thoroughly into the question of technique.

THE BRITISH COUNCIL ANNUAL REPORT

THE annual report of the British Council for the year ended March 31, 1944, covers the tenth year of the Council's work and indicates not only the part the Council has played in the war effort but also its value as an instrument for the no less difficult task of peace to come. Cultural relations are not competitive but reciprocal, and no Government can look with equanimity on the prospect after the War of international competition in this field.

The British Council, with the President of the Board of Trade, initiated a Conference of Allied Ministers of Education in London, and with the Board has borne the burden of its administration, and will continue to do so until it can hand over such responsibilities to a United Nations organization. Plans for providing schools and universities with the necessary books, stationery, laboratory apparatus, radios and film projectors were among the subjects discussed by the Conference. Four lines of development were picked out for special mention in the report: the start of effective work in China, the increasing importance of medicine, the growing interest in British music and the services rendered to the Armed Forces.

the United States of America in Britain. In connexion with the first, the report pays a well-deserved tribute to Dr Joseph Needham, who has been working in China for the past eighteen months. Of these developments, those in regard to medicine, more particularly in contacts in this field with Turkey and the U.S.S.R. and the work in China, are the features of primary interest to scientific workers. The report notes that the Americans in Great Britain are making considerable use of the Council's facilities for professional contacts.

With regard to activities in the British Commonwealth and Empire, the appointment of Sir Harry Luke to the West Indies and of Prof. William Macmillan to West Africa has meant the beginning of serious work. Mr. Malcolm Guthrie has completed a preliminary survey of East Africa. At Malta a new institute was opened in the island of Gozo by Lord Gort. In the British West Indies, the circulation of *Monthly Science News* was largely increased, and the *British Medical Bulletin* was distributed to leading medical men in the area. An extensive library scheme is being sponsored for the islands with a rimid as the centre.

A visit of British surgeons to the Soviet Union as sponsored by the British Council together with the Medical Research Council, and arrangements were made by the Medical Department of the former. American and Canadian authorities were represented. The visit gave many opportunities for the exchange of information on Soviet and British surgical methods and medical research, and the Mission was particularly impressed with the Soviet hospital organization and methods, and with the practice of early specialization in dealing with war casualties and the extremely efficient arrangements for blood transfusion. Books on many subjects have been dispatched for presentation to Soviet institutions, and further supplies of scientific material were sent to the scientific, agricultural and medical sections of the R.O.K.S. More than a thousand reprints and papers published by British scientific men during the past four years have been forwarded, and steps have been taken to centralize in the Science Museum Library, at South Kensington, London, any Russian scientific material received in Great Britain*.

By the summer of 1943, the Council was able to commence work in North Africa, and the supply and dispatch of more than 65,000 volumes of British books to libraries in Algeria, Morocco and Tunisia has been arranged. Events have made the Council almost the only means of cultural contact between Britain and Sweden, and difficulties of transport from September onwards did not prevent its work from rapidly increasing. The exchange of periodicals, mostly scientific, between Britain and Sweden is considerable, and would be much larger if transport allowed, transport also limits the contact between Britain and Sweden in the field of research. Sir Lawrence Bragg, the only lecturer from the Council to visit Sweden during the year, proved a most popular visiting lecturer and spoke on electron microscopy at four university centres and to five anglophil societies. Dr. Dudley Cheesman gave a series of lectures on scientific development in Britain at the Wenner-Gren Institute.

The Council's work in Turkey continues to expand proportionally. The number of British professors holding chairs at the University of Istanbul, on the

recommendation of the Council, is now ten, and there are three at the University of Ankara (see *Nature* October 21, p. 509). The expansion in teaching was accompanied by an extended programme of special lectures, and the Council had four distinguished visiting lecturers in Turkey during the year—Dr. B. Ifor Evans, Dr. H. R. Hamley, Dr. S. J. Davies and Mr. J. Steegman. A Turkish version, translated locally, of the *British Medical Bulletin* was published for the first time during the year, as well as a locally compiled and translated *British Engineering Bulletin*, *British Agricultural Bulletin* and *British Law Bulletin*.

In pursuance of the valuable but difficult project of translating British Standard Specifications into Turkish, B.S.S. No. 132 (Steam Turbines) has been published in England during the present year. Six further specifications have been approved for translation and are completed and awaiting publication, and the translation of fourteen other specifications is being technically checked. Three distinguished Turkish medical men, Prof. B. Tugan, Dr. Avni Aksel and Dr. B. N. Taskiran, visited Britain as the Council's guests and inspected various aspects of medical organization and research.

The Anglo-Egyptian Union is so successful that membership has had to be restricted owing to the lack of accommodation. Membership of the Council's Centre in Brazil increased by fifty per cent during the year, and the distribution of *Monthly Science News* has now risen to 4,000 copies, with large numbers of new requests.

The report includes the full results of Dr. Joseph Needham's valuable scientific work in China. Mrs. Needham later joined her husband. The activities of the Council's cultural scientific position in China commenced on February 24, 1943, when Dr. Needham reached Kunming (Yunnan). Within a fortnight of his arrival, it was reported that co-operation with scientific organizations and individuals had begun and that he had visited more than a dozen universities and research institutes and factories in the vicinity, lecturing on his own field and on topics of general scientific and social interest. Three weeks later he reached Chungking, and on April 3 submitted to the British Ambassador a detailed memorandum on Sino-British scientific relations and cultural co-operation, setting forth the services which might be rendered by a science co-operation officer in China, outlining the possible future developments of such an office and raising the question of technological, as distinct from cultural scientific, aid from Britain to China. Academia Sinica has now agreed to second a scientific worker to assist in matters relating to the Cultural Scientific Office, and the Ministries of Health, National Resources, Agriculture and Education are willing to co-operate. Dr. Needham left Chungking on August 7 on a round trip of 4,000 miles and has now visited more than a hundred scientific institutions in China. Since returning to Chungking he has continued the work of organizing and developing the Cultural Scientific Office. Dr. Needham's valuable and interesting articles published in *Nature* during the summer of 1943 are evidence of his activities.

Of great importance to the Chinese war effort and for the development of all branches of science in China is the supply of information and constructive ideas on the problems arising in pure and applied science. The Council's Office constitutes the link between the Chinese Ministry of Health and the

* Russian periodicals received at *Nature* office also are eventually sent to the Science Library.

Medical Research Council in Great Britain between the Chinese Ministry of Economics and Natural Resources and the Department of Scientific and Industrial Research, etc

A fund has been set up in India for the maintenance of a Scientific Supply Service, so that the essential needs of Chinese research institutions, etc., many of which are engaged on war work may be met. Six copies of current issues of some seventy-five British scientific journals are regularly sent to China for distribution by the Cultural Scientific Office, and it is hoped to arrange for a Chinese edition of *Monthly Science News* to be published in Chungking. *Monthly Science Abstracts and Reviews* and copies of *Endeavour* are distributed through Academia Sinica. Six positive micro-film copies of each of these seventy-five scientific journals are being sent regularly to China for distribution by the International Committee for the Supply of Scientific and Cultural Reference Materials, and this organization also handles all American supplies of micro-films. British scientific films are being supplied to the Department of Educational Cinematography of Nanking University, and a number of offprints of scientific papers from British journals have been transmitted to China at the author's wish or on request from Chinese workers. The number of text-books and monographs on scientific subjects which have reached China in response to requests passed on by the Council's Office runs into hundreds. Thirty manuscript papers in English by Chinese workers have been submitted for publication through the Chungking Office to editors of British scientific journals, and a panel of translators from Chinese to English has been assembled so that scientific papers of special interest can be translated or abstracted. A grant has been made for the preparation of abstracts in English of Chinese publications on chemical matters, and at least four hundred current Chinese scientific publications have been distributed through the Council to British scientific workers and science libraries. A science news letter, *Acta Brevia Sinensia*, giving an account of current Chinese scientific activities, is duplicated and distributed by the British Council in Great Britain. Prof. E. R. Dodds returned from China in the summer of 1943 after a successful tour of the university centres, Mr. E. Hughes has been in China since May 1942 and was remaining until the end of September 1944. Prof. W. L. Renwick, who reached China more recently, has already submitted a report on the fine arts in China.

WORK OF THE ROYAL ARMY VETERINARY CORPS

MAJOR A. V. FRANKLIN, writing in the *Veterinary Record* (447, Nov. 18, 1944), tells one of the most interesting and humane stories of this war. As a result of the progressive mechanization of our armed forces before the War, the Royal Army Veterinary Corps was very considerably reduced, and some prophets decided that it would never be revived. How wrong they were they will learn from Major Franklin's article. When a cavalry division was formed for service in Palestine, veterinary units of the Royal Army Veterinary Corps were organized to attend to its animals. Mobile units were also serving, at the outbreak of the War, the two cavalry

regiments stationed in Palestine. Other veterinary units were attached to Indian and Cypriot mule pack transport companies operating in France. This was the extent of the British Army veterinary service until the end of 1940.

In 1941, however, a striking change occurred. The duties of the Army Remount Service were transferred to the Royal Army Veterinary Corps, which thus undertook the purchase, training and maintenance of animal reinforcements, as well as the care of the animal sick and injured. In the difficult countries of Eritrea and Greece, where pack animals played such an important part, the Royal Army Veterinary Corps had ample opportunity to prove its efficiency. In Greece many veterinarians were taken prisoner and some heavy casualties were incurred. One of the saddest tasks was the rescue, by the mobile section stationed at Alexandria, in veterinary charge of the Polish Carpathian Brigade, of hundreds of mules in the North African desert. The Italian fleeing before Lord Wavell had left them there without food, water or attendance and their condition was deplorable, but they were soon restored to proper veterinary care. In Syria, several regiments of yeomanry operated with their own veterinary officers and also two mobile veterinary sections. It was here that the Royal Army Veterinary Corps showed the efficiency of its remount organization. Horses of all kinds were taken over from the Vichy French, classified, examined for disease, branded, shod and generally conditioned before they were re-issued for service with the Allies. Here also many horses and mules were found deserted by the attendants without food or water and often in pitiable condition. While this task was being completed, yeomanry and cavalry regiments were being mechanized and their horses were taken over and trained for transport work.

In 1942, the Royal Army Veterinary Corps was given the task of meat inspection and administration of the livestock depots from which the Army's meat supply was derived. The stock were inspected both before and after slaughtering, and this service was so beneficial that it was extended throughout the Middle East. The existing slaughter-houses were often so insanitary that the Royal Army Veterinary Corps designed and built new ones with adequate rail and road facilities. The serious danger of transmission to man of certain animal parasites which are very prevalent in bovines was removed. Later the Corps undertook the actual selection of the beasts provided by local contractors, who soon learnt that inferior stock would not be accepted. Often, indeed they could not supply beasts of sufficiently high quality, and the Royal Army Veterinary Corps established its own livestock depots, first in Syria and later throughout the Middle East, in which cattle, sheep, goats and pigs were reared and supplied to the Forces. Patients in the hospitals received their meat in the form of rabbits from the Corps' rabbitries. One of these depots, carrying a stock of 1,500, was able to produce 150 animals a week. The commanding officer of this depot has reported that, in Syria, parasitic disease in sheep and goats caused the death of one million animals in one winter alone, a loss which amounted to three million pounds sterling, one quarter of the annual budget of the country. In Italy, the Royal Army Veterinary Corps has perhaps its most difficult task. Many of us have heard about the mules used in this extraordinary campaign but we have not all realized how much our m

re to the RAVC, which bought, conditioned, and issued these invaluable animals. This work called for high administrative and business skills had to be sought out in many countries, and the right types had to be selected and transported across land and sea. Many veterinarians were required for the pack transport companies and more for the mount depots, animal hospitals, mobile sections and laboratory services. Evacuation of animal casualties from the line and the supply of reinforcements was one of the most eagerly sought jobs in the veterinary service. The Corps is now considering the extensive use of dogs.

It is certainly true that, as Major Franklin says, the story of all this work, when it can be told in full, will bring great honour to the veterinary profession and much of the veterinarian's work, in peace-time as well as in war, is unspectacular and done with a quiet efficiency which does not get into the news. It deserves the admiration and gratitude of all who care for animals.

G LAPAGE

RELATIVITY OF TEMPERATURE RADIATION

IN his Halley Lecture¹, Prof H Dingle gave an outline of an entirely new application of relativity principles to thermal radiation. He has now published a more detailed account² which shows how the theory has been worked out. The fundamental idea is that "our theories should not imply the possibility of observing what is, in fact, unobservable" thus in Einstein's theory of two bodies moving with uniform relative velocity, it is only this relative velocity and its limiting value which are of importance. Moreover, the equality of the inertial and gravitational mass is regarded not as a remarkable coincidence, but as establishing that these two masses are two aspects of the same property.

Guided by this analogy, Prof Dingle deals with the radiation of a black body, of constant temperature, in terms of its effect upon a second black body. He regards the equality of the emissive and absorptive powers as establishing that these are two aspects of the same property. It should have been pointed out that this equality exists only when the powers are defined in a general way³. The conventional definitions⁴, which give absorptive power as a pure number, that emissive power as a quantity with dimensions, obscure this equality.

The most important part of Prof Dingle's theory seems to be the analogy between the three kinematical variables, displacement, time and velocity, and three thermal variables, entropy received by a certain instrument, 'thermal time', and what I will venture to call 'radiosity', though he calls it 'radiation temperature', simply 'temperature'. It is certainly not the usual absolute temperature, as it is approximately proportional to its fourth power. The 'thermal time' is measured by a 'thermal clock', which records what ordinary terms would be called the total amount of radiant energy received from a black body radiating at a constant rate. In terms of these variables, Stefan's law of radiation takes the form 'radiosity rate of change of entropy', exactly analogous to 'velocity is rate of change of displacement'. Moreover, when the zero of 'radiosity' is changed, the three thermal variables are transformed by formulae that correspond

roughly (but not in detail) with the Lorentz transformation formulae of Einstein's theory. Finally, there is an invariant thermal interval, but this involves an expression of the fourth degree in the differentials, whereas the kinematical interval of space-time involves only one of the second order.

Two applications of the theory are to the maximum efficiency of a heat engine working between fixed temperatures, and to the general equations of the thermo-electric circuit. It is difficult to find other applications, as there are few phenomena which depend only on temperature differences, do not appreciably alter the temperature, and are independent of the properties of particular substances. It is emphasized that the theory, at any rate in its present form, deals only with radiation, no claim is made that all thermal phenomena are independent of the zero of temperature.

Prof Dingle concludes by indicating how the limitation of constant temperature might be removed. As in the extension of the special theory of relativity to the general theory, it would be necessary to deal with tensors, but in the thermal case the work would be much more difficult. Perhaps some enterprising young mathematician may care to tackle this. If Prof Dingle's arguments are sound, they open up a new line of approach to the theoretical study of radiation and a new opportunity for the use of the tensor calculus.

H T H PIAGGIO

¹ *Nature*, 153, 731 (1944)

² *Phil Mag*, 35, 499 (1944)

³ Preston, "Theory of Heat" (4th ed.), 494

⁴ Preston, "Theory of Heat" (4th ed.), 541-42

INDIAN ASSOCIATION FOR THE CULTIVATION OF SCIENCE

THE annual report of the Indian Association for the Cultivation of Science for the year 1943 includes the presidential address, the report of the committee of management, including lists of papers published in the *Indian Journal of Physics*, vols. 16 and 17 and in the *Proceedings of the Association*, and appendixes on the scientific work of the Association. The membership increased from 157 to 213 during the year, and of the latter figure 133 are life-members.

The report on the scientific work of the Association refers to a study of primary extra reflexions in Laue photographs, in which the exact location of the absolute maximum of each extra spot at different orientations of a crystal, the spread of the intensities of the spots along different directions, the change of maximum intensity with variation in the angle of incidence, and the deviation of the direction of maximum intensity from the planes of incidence are being studied. A closer study of the extra reflexions in Laue photographs of phloroglucinol crystals indicated that these reflexions are also of the secondary type and originate from the lattice degradations along the trigonal and the diagonal axes, and further investigations of this effect in benzil are in progress. Attempts are also being made to obtain accurate values of the atomic parameters in benzil crystals by a two-dimensional Fourier analysis.

Investigation of the magnetic behaviour of rare earth ions in crystals at low temperatures led to the conclusion that the paramagnetic units do not change with temperature, but the angle between the various paramagnetic units and the unit cells in these crystals

changes with the temperature. Magnetic studies have confirmed the predictions as to the fine structure of potassium permanganate single crystals drawn from X-ray studies. The Hall effect of molybdenite has also been investigated, and in a study of the fluorescence of anthracene crystals containing naphthalene, excited by monochromatic radiation, it has been shown that the position and number of fluorescent bands of naphthalene are independent of the wave-length of the radiation, and that the intensity of fluorescence rapidly falls to zero as the wave-length of the exciting radiation increases beyond the central part of the longest absorption band.

Research work carried out by Dr S C Sirkar covers the Raman spectra of ethyl, methyl, propyl and butyl sulphide in the solid state at the temperature of liquid oxygen. The investigation has been extended to aromatic compounds of high boiling point, such as benzyl alcohol, benzylamine and benzoyl chloride. An X-ray analysis of jute fibre has led to the grouping of the fibres into four broad classes, and the result may lead to the development of a method of classification of jute fibre similar to that adopted by the U.S. Government for cotton fibres. Mr B C Guha has studied the temperature variation of anisotropy of many paramagnetic ions in crystals of salts of the iron group of metals over the temperature range 300° – 80° K.

FORTHCOMING EVENTS

Monday, January 15

ROYAL GEOGRAPHICAL SOCIETY (at Kensington Gore, South Kensington, London, S W 7), at 8 p.m.—Brigadier R. A. Bagnold "The Early Work of the Long Range Desert Group."

Tuesday, January 16

BRITISH PSYCHOLOGICAL SOCIETY (INDUSTRIAL SECTION) (at the London School of Hygiene and Tropical Medicine, Keppel Street, London, W C 1), at 1.15 p.m.—Dr A. H. Seymour "Psychological Problems of the Personnel Function in Industry."

ROYAL SOCIETY OF ARTS (DOMINIONS AND COLONIES SECTION) (at John Adam Street, Adelphi, London, W C 2), at 1.45 p.m.—Mr G. B. Gresford "Scientific Aspects of Australia's Industrial Development."

EUGENICS SOCIETY (at the Royal Society, Burlington House, Piccadilly, London, W 1), at 5 p.m.—Mr Cecil B. B. B. "Eugenics and Criminal Law."

INSTITUTION OF CIVIL ENGINEERS (RAILWAY ENGINEERING DIVISION) (at Great George Street, Westminster, London, S W 1), at 5.30 p.m.—Mr F. H. D. Page "Railway Signalling for the Civil Engineer."

INSTITUTION OF ELECTRICAL ENGINEERS (RADIO SECTION) (at Savoy Place, Victoria Embankment, London, W C 2), at 5.30 p.m.—Discussion on "Frequency Allocation for Long Distance Communication Channels (over 1000 Miles)" (to be opened by Dr R. L. Smith-Rose).

ROYAL PHOTOGRAPHIC SOCIETY (SCIENTIFIC AND TECHNICAL GROUP) (at 16 Princes Gate, South Kensington, London, S W 7), at 6.15 p.m.—Mr P. S. Milne "Photography and Bee-Keeping Research."

Wednesday, January 17

ROYAL SOCIETY OF ARTS (at John Adam Street, Adelphi, London, W C 2), at 1.45 p.m.—Mr Christian Barmar "Design in Modern Transport."

INSTITUTE OF FUEL (MIDLAND SECTION) (at the James Watt Memorial Institute, Birmingham), at 2.30 p.m.—Mr A. T. Green "The Properties of Refractory Materials and their Significance to Fuel Economy."

GEOLOGICAL SOCIETY OF LONDON (at Burlington House, Piccadilly, London, W 1), at 3 p.m.—Mr Fred Wolverson Cope "Intraformational Contorted Rocks in the Upper Carboniferous of the Southern Pennines."

ROYAL ENTOMOLOGICAL SOCIETY OF LONDON (at 41 Queen's Gate, South Kensington, London, S W 7), at 3.30 p.m.—Annual Meeting Dr E. A. Cockayne "Some Contributions of Entomology to Genetics" (Presidential Address).

ROYAL STATISTICAL SOCIETY (at the London School of Hygiene and Tropical Medicine, Keppel Street, London, W C 1), at 5.15 p.m.—Mr M. G. Kendall "The Analysis of Oscillatory Time Series."

WOMEN'S ENGINEERING SOCIETY (MANCHESTER BRANCH) (at the Engineers' Club, Albert Square, Manchester 2), at 6.30 p.m.—Mr G. E. Windeler "Mechanical Mishaps and Industrial Accidents."

Thursday, January 18

CHEMICAL SOCIETY (at Burlington House, Piccadilly, London, W 1) at 2.30 p.m.—Prof J. Monteath Robertson "Diffraction Methods in Modern Structural Chemistry" (Tilden Lecture).

SOCIETY OF CHEMICAL INDUSTRY (PLASTICS GROUP) (at the Ro Institution, 21 Albemarle Street, London, W 1), at 5 p.m.—Dr L. Jordan "Paint—The Art and the Science" (Jubilee Memo Lecture).

INSTITUTION OF ELECTRICAL ENGINEERS (at Savoy Place, Victoria Embankment, London, W C 2), at 5.30 p.m.—Discussion on "Second Report on Education and Training for Engineers dealing with Part-time Further Education at Technical Colleges, including Courses for those returning from the Services."

IRON AND STEEL INSTITUTE (joint meeting with the STAFFORDSHIRE IRON AND STEEL INSTITUTE) (at the Dudley and Staffordshire Technical College, The Broadway, Dudley), at 7 p.m.—Prof F. C. Thompson and Dr L. R. Stanton "Some Observations on the Austempering and Isothermal Transformation of Steels with special reference to Production of Martensite."

BRITISH INSTITUTE OF RADIOLOGY (in the Reid-Knox Hall, 32 W. Beck Street, London, W 1), at 8 p.m.—Symposium on "Clinical Photography."

Friday, January 19

INSTITUTION OF ELECTRICAL ENGINEERS (MEASUREMENTS SECTION) (at Savoy Place, Victoria Embankment, London, W C 2), at 5.30 p.m.—Mr H. J. Josephs "The Fixing of Confidence Limits to Measurements."

INSTITUTION OF MECHANICAL ENGINEERS (at Storey's Gate, James's Park, London, S W 1), at 5.30 p.m.—Mr Antony R. Vickie "The Engineer and the Nation's Money."

INSTITUTE OF FUEL (SCOTTISH SECTION) (joint meeting with SOCIETY OF CHEMICAL INDUSTRY) (at the Royal Technical College, Glasgow), at 5.45 p.m.—Prof D. T. A. Townend "The New Light in Combustion."

APPOINTMENTS VACANT

APPLICATIONS are invited for the following appointments on or before the dates mentioned.

CIVIL ENGINEER by the Government of Ceylon, for appointment IRRIGATION ENGINEER—The Ministry of Labour and National Service Central (T and S) Register, Room 5/17, Sardina Street, Kingsway, London, W C 2 (quoting Reference No. E 1030 A) (January 19).

MATHEMATICAL PHYSICIST to join a small research team working on problems connected with welding—The Secretary, The University of Birmingham, Birmingham 3 (January 20).

PRINCIPAL OF THE BARNSTAPLE SCIENCE, ART AND TECHNICAL SCHOOL—The Secretary for Education, County Education Office, Castle Street, Exeter (January 20).

ADVISED IN AGRICULTURAL ZOOLOGY—The Acting Registrar, School of Agriculture, University College of North Wales, Bangor (January 22).

LECTURER (full-time) in ELECTRICAL ENGINEERING—The Principal, Royal Technical College, Peel Park, Salford 5, Lancs (January 22).

LECTURER IN METALLURGY—The Secretary, The University of Birmingham, Birmingham 3 (January 30).

EDUCATIONAL PSYCHOLOGIST—The County Medical Officer, Public Health Department, Shire Hall, Nottingham (January 31).

COMMISSIONER OF PUBLIC HEALTH, Perth—The Agent-General, Western Australia, 115 Strand, London, W C 2 (February 1).

ASSISTANT HYDROGRAPHIC SURVEYORS by the Kenya Government Public Works Department—The Ministry of Labour and National Service, Central (T and S) Register, Room 5/17, Sardina Street, Kingsway, London, W C 2 (quoting Reference No. E 904 A) (February 12).

SUPERINTENDENT OF THE HAROLD COHEN LIBRARY, and three SENIORS (two in the Faculty of Arts, and one in the Faculty of Science)—The Registrar, The University, Liverpool (April 26).

ASSISTANT CHEMISTS (two) for Laboratory investigating Colour materials—The Establishment Officer, Imperial Institute, South Kensington, London, S W 7.

REPORTS and other PUBLICATIONS

(not included in the monthly Books Supplement)

Proceedings of the Royal Society of Edinburgh Section A (Mathematical and Physical Sciences) Vol. 62, Part 2, No. 14. On Substitutional Equations. By D. E. Rutherford. Pp. 117–126. 1s. 9d. Vol. 62, Part 2, No. 15. Quantum Mechanics of Fields. 2. Electromagnetic Field and Electron Field in Interaction. By Prof. Max Born and H. W. Peng. Pp. 127–137. 2s. Section B (Biology) Vol. 62, Part 10. Mitosis and Cell Differentiation in the Blood. By L. La Cour. Pp. 73–85 + 3 plates. 3s. 3d. Vol. 62, Part 1, No. 11. Recent Advances in the Study of the Brain as the Implement of Mind. By Dr Richard J. A. Berry. Pp. 86–95. 1s. 6d. Vol. 62, Part 12. The Histochemical Demonstration of Ribonucleic Acid in Mammalian Liver. By Dr J. N. Davidson and Dr C. Waymo. Pp. 96–98 + 1 plate. 1s. Vol. 62, Part 1, No. 13. The Appearance of Cross-sections of the Hairs of some Carnivores and Rodents. By J. L. Stoves. Pp. 99–104 + 3 plates. 2s. 3d. (Edinburgh and London: Gurney and Jackson.)

Re-educating Adults. An Essay on Adult Religious Education. Canon R. E. Parsons. Pp. 32. (London: Churches' Committee Supplementing Religious Education among Men in H.M. Forces.) 1s. 6d.

Ministry of Health. Local Government in England and Wales during the Period of Reconstruction. (Cmd. 6579.) Pp. 20. (London: H.M. Stationery Office.) 4d. net.

Institution of Electrical Engineers. Education and Training of Engineers (Second Report). A Report to the Council from the War Planning Committee on Part-Time Further Education at Technical Colleges including Courses for those returning from the Services. Pp. 40. (London: Institution of Electrical Engineers.)

NATURE

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HUMAN PROBLEMS IN THE DISPERSAL OF INDUSTRY

IN the White Paper on Employment Policy, as one method of dealing with the problems of local employment and securing a balanced distribution of industry and labour, the Government proposal is to exercise a substantial measure of control over the location of new industrial development, as is contemplated in the Barlow Report. The importance of such measures has been repeatedly emphasized in various connexions, particularly with reference to such regional proposals as the Greater London plan recently prepared by Sir L P Abercrombie, of which a limited working edition has been released to the Press and to the local authorities. Nevertheless, it is clear that so far there are no powers for giving effect to such regional plans, nor, if and when such powers are forthcoming, is the regional planning machinery adequate for the purpose. Furthermore, it is by no means certain that public opinion is yet prepared to accept the limitations on personal freedom and initiative implied in any large-scale measure of regional or national planning.

It is this last point that may well prove a crucial difficulty. The agitation against controls in general, and the extravagant form which the recent protest against the transfer of Civil Servants involved in the proposed location of the Ministry of National Insurance at Newcastle-on-Tyne took, are pointers to which the planners must pay full attention. No blueprints or plans, on the regional, the national or the local scale, will have their full effect or be tolerated for long by the community, save in so far as they give expression and satisfaction to the hopes and needs of individual men and women, and secure the integration, and not the suppression, of the individual, with the purposes and needs of the community as a whole.

This individual and personal point of view is commonly overlooked in planning, and yet it is the one that is most vital if the plans are to be accepted and executed by the community and for the community. The report of the Social and Industrial Commission of the Church Assembly, in 'The Church and the Planning of Britain', has commented on the failure of the most recent housing developments to provide adequate facilities for a natural community life, and on the social disintegration involved in enforced migration. The County of London Plan, for example, was prepared on the general assumption of the removal of about half a million people from the London County Council area, and the Greater London plan involves the resettlement of roughly a million people altogether from the County and from the first two rings—'suburban' and 'green-belt'—around it. A quarter of those, it is suggested, should go to existing towns, and nearly 400,000 to eight entirely new satellite towns, mainly in the 'outer county' ring; a further quarter of a million should go right off the map beyond the orbit of the plan, while 125,000 would be accounted for by existing immediate housing schemes.

Population movements of this scale are quite impossible without a parallel and co-ordinated decentralization of industry, and in the Greater London plan great care has been taken to select the new sites with full reference to their industrial suitability. The choice of brand new towns as the main reception areas for decentralization is a bold feature of the plan, but the experience of the trading estates and of the Commissioners for the Special Areas shows how difficult it is to attract both industry and workers to new rather than to existing centres. Moreover, the experience of the compulsory uprooting involved in decentralization and dispersal from London under the emergency of war does not encourage excessive optimism as to the welcome which further uprooting and dispersal would receive generally. Willing acceptance will mean the clear and painstaking explanation and demonstration of the benefits to efficiency and welfare of firms and workers which will result.

The vital importance of such educational work clearly emerges from the important study of dispersal made by the National Council of Social Service at the request of the Bank of England, which has now been published*. This inquiry was concerned with the location of clerical and administrative staffs of considerable size, whether attached to industrial organizations or not. It is not concerned with industrial location as such, but this attempt to analyse the social advantages and disadvantages of dispersal as a permanent arrangement clearly has a close bearing on the centralization or decentralization of large scientific and technical organizations such as research institutions, as well as head-office administrative staff in the usual sense. The study covers the general national interest, the interests of the organization concerned and of the reception areas as well as of those vacated, but is of special importance for the prominence given to the point of view and interests of the staff affected, hitherto largely neglected in such discussions. To this the longest two chapters of the report are devoted, for that on educational and health services is essentially a further elaboration of a subject of special importance from the point of view of the staff.

So far as war-time experience is concerned, the Committee, of which the Right Hon. Walter Elliott was chairman, is convinced that dispersal is both desirable and possible. To secure a happier social life generally, the sundering of the family by the ever-lengthening daily journeys of its units and the growing concentration of population in and around a few large cities must be arrested. The war-time evacuation took place under unfavourable conditions, and many of the elements of the planning that was essential to full success were absent. It is the more important to see that the lessons to be learned are applied in preparing the basis of permanent schemes.

From the conflicting evidence, the Committee derives the impression that, of the reception areas,

fairly large towns of 40,000–100,000 inhabitants, with good cultural facilities, usually gave most satisfaction. Except for a few quite small staffs, evacuation villages or to large houses in open countryside has been unpopular. It allayed unrest if at least one director or other highly placed official lived on the spot, and it helped immensely to be within easy reach of the home city, and to have facilities for occasional visits to it.

While it is now proved that dispersal is a practical possibility, given sufficient incentive, it seems clear that the majority of heads of organizations regard evacuation as a war-time expedient and intend to return as soon as the War ends. There is little doubt that the majority of the evacuated staffs, too, would vote for a return after the War to London or whichever other city they left. It is something, however, that a substantial minority of the workers should require longer years for the city, and this minority may be an important factor in the success of that planned dispersal which is so overwhelmingly desirable in the national interest.

The selection of the town for dispersal is only the first factor requiring consideration, and in this selection regard should be had not only to the town as it is now is, but rather to its future possibilities. Close related is the question of re-housing, and here the report suggests the formation of a housing association to avoid the objections to company houses and municipal houses. Again, it is pointed out that there is a strong case for widening the powers of borough councils under the Housing Acts already in existence.

Scarcely less important is the question of educational provision. Here the report notes that what under the Education Act a considerable improvement in the unequal distribution of the main types of educational provision may be expected, there may be a difficult transition period during which the prudent selection of reception towns will be necessary in order to relieve the apprehensions of many employees with regard to education—and to medical and health services also. Many towns of moderate size offer satisfactory provision to parents of modern means, but the town needs to be selected with care and the most important consideration at present is that the local authority should be progressive and generous. Similarly with regard to medical and health services, disadvantages compared with great cities need not be serious so far as most of the minor ills are concerned, but the existence of a well-managed hospital, with a number of private beds at a reasonable cost, is a matter of great importance. Fairly easy access to a great city or university town where there are medical schools and special facilities is also important.

Provision for the use of leisure is of great importance also, though here it is clear there are certain misconceptions and misunderstandings to remove. Facilities for indoor recreation are usually much better and much dearer in great cities than in small and medium-sized towns. For outdoor recreation the reverse is generally true. Here the report, stressing the importance of good public libraries, urges

* Dispersal: an Inquiry into the Advantages and Feasibility of the Permanent Settlement Out of London and other Great Cities of Offices and Clerical and Administrative Staffs. Made by the National Council of Social Service. Pp. x+96. (London, New York and Toronto: Oxford University Press, 1944.) 3s. 6d. net.

value of the greater opportunity for participation in communal and municipal life in the medium-sized town. This is regarded not merely as affording a way of self-expression and integration with the community, it is urged on employers that the scope provided in this way for young people to take an active part in the civic and social affairs of their neighbourhood will bring them experience which may enhance their qualifications as future managers and directors.

The relative advantages of provincial towns in this connexion, as compared with large cities, require further exploration before this argument can be used in favour of dispersal, but here, as elsewhere, the report indicates the factors which have to be taken into account and also some of the fallacies responsible or present preferences. This indeed is the main value of the report, which never suggests that the experience gained in the evacuation of the 200,000 or more employees with which it is directly concerned is all that is relevant. On the contrary, it points to other recent migrations, such as that into the Home Counties during the years 1927-39, the settlement of coal-miners in the new Kentish coal-field, the growth of new housing estates such as Becontree, and the settlement and development of Corby, which although not strictly parallel, represent experience from which, with due care, useful inferences can be drawn.

Assuming that dispersal is agreed upon as a policy, there are three phases to be distinguished: the first period of transition, possibly a year or more, when the actual transfer from the old to the new location is made, a second period, ending only when the generation of those transferred has passed, and the final settled period, when the staffs, or the overwhelming majority of them, had been recruited to serve in that locality. Only then will the considerable social stresses involved in dispersal disappear, and it is the existence of such inevitable social stress that gives enhanced importance to such questions as salaries and hours of work, and generous treatment in regard to removal expenses and housing, and prospects of promotion.

Finally, the report emphasizes the overwhelming case in the national interest for some measure of dispersal so far as London is concerned, and urges that the Government should assist by making it clear that it is in favour of such a policy and participating whole-heartedly in any general movement in respect of its own staffs. It should use its influence with large organizations to induce them to disperse. It should request local authorities to give all possible help in reception areas, and if local authorities need new powers to enable them to play their part adequately, as for example in housing, the Government should see that the necessary legislation is introduced. Parliament may reasonably be asked to give financial assistance to local authorities to enable them to play their part.

As already indicated, it is as a stimulus to the further examination of the problems involved and for its welcome emphasis on the personnel factor that this report is most valuable. It never claims too

much, but it does demonstrate that dispersal is practicable, and that it could be made a success: those concerned will give the necessary attention to the all-important details of planning, and above all to what may be best described as digging the channels of assent. Government support is essential, not the least because the full implementation of its expressed intentions as to the development of educational, medical and health services and social insurance are vital factors in promoting mobility, while its power with regard to building and other priorities could also be used constructively to give positive assistance to a dispersal policy and programme. The integration of the individual citizen affected into a new community, giving him or her full satisfaction, will never be achieved by direction from the top alone, the difficulties of personnel so lucidly outlined in the second appendix to this report must also be handled with sympathetic insight, with wisdom, courage and vigour. The support and co-operation of the staff concerned must be secured by putting before them clearly and convincingly the national and communal reasons which make dispersal to-day imperative.

THE VAGABOND LIFE

Gypsies of Britain

An Introduction to their History. By Brian Vesey-FitzGerald. Pp. xvi+204. (London: Chapman and Hall, Ltd., 1944.) 15s. net.

READERS of *Nature* are probably familiar with Mr Vesey-FitzGerald's name as a prominent naturalist and a distinguished chiropterist (he ever shelters young bats inside his vest, feeding them with gentles held in his mouth). They may know further that he was for long the natural history editor, and is now editor, of *The Field*. But few know him as a writer of one brilliant story dealing with the episode of Sisera and Jael, and still fewer, until this year, knew that he is as much of a gypsy as anyone other than a pure Romany can be. Now he has given us a most interesting book on the gypsies of Britain. For the accuracy of this book I can vouch, because in the course of a medical experience of more than fifty years I, too, have studied gypsies and doctored all who came my way, in all sorts of conditions, from the heaths of West Cornwall to the open fairs of East London.

That the book is thorough no one opening its pages and looking at its table of contents could question. I have spoken of its accuracy. Its ultra-modesty is perhaps its only flaw. In his prefatory remarks, the author "acknowledges his indebtedness" to dozens of persons, not one quarter of whom could hold a candle as authorities to Mr Vesey-FitzGerald himself. I am inclined to think that he has been rather taken in by fictitious pundits as to the nature of the Romany language, though he, himself, correctly uses and pronounces several words known to all true Romanies. I like him best when he talks really first-hand. He first read "Lavengro", that half-fictitious classic, when he was sixteen, but, he says, "I first knew a Gypsy when I was seven or thereabout. Then an itinerant harper came through the little country town where we lived. Father liked the harp and he liked characters too, and for several days the man came and played his harp outside our house. Father

talked to him and I would go out and listen, and the man would always talk to me also. My father was a great walker. And from the time that I was eight he would take me with him on many of his walks. Among the people we got to know on these walks were tramps and several families of Gypsies, who travelled the area. I had my first food in gypsy encampment when I was nine. I had my first meal alone in a Gypsy encampment when I was eleven."

People are apt to confuse real Romanies or such as carry on the true Romany tradition though not, perhaps, 'pure-bred' with all kinds of road travellers owning caravans or carts, with or without tents. Hence the bad repute into which the whole of gipsydom has fallen among the ignorant section of the public. The nearest approach to anything that can be called fraud which can be fairly attributed to gypsies are fortune-telling, and sometimes horse-coping. They are not thieves, though they may use some hazel-rods to make their tents with, or odd bits of wood lying about for their camp fires. They do not suck blood or run away with other people's children, they generally have quite enough of their own. They treat their animals well—indeed, almost as members of the family.

One of the most interesting chapters of this book is that devoted to gipsy marriages and marriage customs. The author has always found gipsy girls to be modest and chaste in their bearing, though, he says, this does not apply to their speech. Gypsies look upon marriage rather differently from ordinary conventional people in Britain. Quite often they are polygamists, as is illustrated in Borrow's writings. After all, gypsies are Oriental in origin. Mr Vesey-FitzGerald gives an example, observed by himself, of the difference between the Oriental code and the English code. He tells us that, some years before the War, he was staying at the same hotel in France as was a very rich Oriental. "He had four wives (three of them English, and the fourth German) and they all lived together." Yet the gypsies are very keen on pre-nuptial chastity. At one time—not so very long ago—English gipsy girls used to wear a sort of girdle of chastity 'made of wool mounted on catskin, from the age of twelve until the wedding day. It was fastened on by the mother every morning and removed by the mother every night, and was carried before the girl as a token of her maidenhood when she was married.' According to Philip Murray, a friend of Prof. Sampson, it was then kept by the husband until it was required by the eldest daughter. Murray was an Irish tinker, who married into one of the many Gipsy Smith families. Of course, all these things have long disappeared, but a high degree of real modesty is still almost universal.

Very interesting chapters of this book are devoted to the early and the recent history of the gypsies in England and Scotland. We are told that James V signed a writ of the Privy Council of Scotland by which the gypsies were granted astonishing privileges. This writ was in effect a treaty between the King of Scotland and John Faw, a leading member of the tribe, whose name will be familiar to readers of S. R. Crockett's novels.

Interesting, also, is the chapter devoted to "Gipsy Waggon." Though not all gypsies own 'waggons', all seek their possession. The waggon is the gipsy's most valuable property. "It is home, and in it he carries his most treasured belongings—clothes, linen, china, a few photographs, perhaps medals won by himself

or his family in the last war. But no true gipsy ever talks of a caravan—unless he means one of the luxurious edifices that in the piping days of peace we used to see trailing behind fast cars—he talks of a waggon or a van. And the word *vardo* really means 'living-waggon'. In 1840, the year of publication of Dickens' "Old Curiosity Shop", we got a full description of Mrs Jarley's waggon or caravan. That caravan is fundamentally like the caravan of to-day. The author of the present book gives a very complete and accurate picture of the typical living waggon now used. "It is a one-roomed house on rather high wheels, with windows at the back and sides and door and detachable steps at the front. There is a rack (known as the *cratch*) at the back for carrying domestic articles of various kinds, and underneath the waggon at the back there is built a cupboard (known as the pan-box) which serves as larder and kitchen cupboard. Inside the waggon, behind the door, as a coal-stove, with a chimney projecting through the roof, a cupboard and a locker-seat. On the other side there is a corner cupboard for china, a chest of drawers in which is kept the family wardrobe and the family linen, and another locker. The whole of the back part is occupied by a two-berthed sleeping place. Naturally, just as there is some variation from waggon to waggon in external design, so all waggons are not fitted exactly in this way. But the variations inside is so slight that this description may truly serve as a standard."

Not all gypsies, however, possess or desire such a luxurious home as this. I well remember when I was in practice in Cornwall, a plot of heathland on which was a sort of permanent encampment, consisting of several caravans and tents, with fires burning, and every morning proceeding from it a little slim old lady, aged eighty-two or eighty-three, walking with a good stride and bolt upright, balancing on her shoulders two long poles from which were suspended baskets, and strings of clothes-pegs—two common products of gipsy industry—marching off to the neighbouring villages to offer her goods for sale. One day she confided to me that she was born under hedge and, pray God, she hoped to die under a hedge.

But to return to Mr Vesey-FitzGerald's book. There are chapters on gipsy medicine, fortune-telling, social organization, death and burial and other matters. It is to be hoped that this book will be widely read, and induce among hitherto prejudiced readers a little tolerance towards, and understanding of, gipsy ways and gipsy characters.

HARRY ROBERTS.

BRITISH ELECTRIC POWER STATION PRACTICE

Electric Power Stations

By T. H. Carr Vol. 2 Second edition, revised and enlarged Pp. xii+549 (London: Chapman and Hall, Ltd., 1944) 32s. net

IN the review of the first volume of the above work (*Nature*, 153, 729, 1944), attention was directed to the importance of electric power stations, and it is evident that public interest in these is increasing partly due to certain controversies which have arisen regarding interference with amenities, but largely because of the growing realization of the value of electricity in everyday life.

The second volume now appears in its second

dition. It describes condensing plant, feed heating, and water treatment plants, and then deals with electrical machines and equipment. Supplementary chapters are devoted to plant-testing organization, station costs, fire-fighting and air raid precautions. It will at once be seen that the division of the material between Volume 1 and Volume 2 is illogical, it would have been preferable to have had all the steam and water components in one volume, leaving the second mainly for electrical plant.

It is doubtful if anyone inexperienced in power station practice could derive much benefit from reading this volume. Individual chapters are too elementary and inconsequential to be of value to well-informed specialists. Practically every one of them is a jumble of descriptive matter, empirical formulae and so-called tables of data. The arrangement is haphazard, and it appears that the author merely introduced tables of data at random.

Power station engineers are, however, a class apart, and many of them may find the volume acceptable because of the numerous references to troubles which have been experienced, and the descriptions of means whereby their recurrence can be prevented. A certain pleasure is also to be derived from the evident enthusiasm and energy of the author which is revealed throughout the work. His benevolent interest in the humanitarian side of management is frequently brought out in a commendable manner.

Alternators, transformers and reactors, switchgear and cables, which constitute the main components of the electrical equipment of a power station, are described tolerably clearly, and are illustrated by familiar examples from everyday British practice. Station auxiliaries, their connexions and methods of supply, have constituted a subject of controversy for many years, and a good deal of useful information is provided regarding the numerous alternatives, but the author does not come to any specific conclusion as to order of merit.

Considerable emphasis is laid on electrical protective equipment for power station plant, and the chapter dealing with this subject would serve as a useful introduction to protective gear installation and maintenance.

Another subject of first-rate importance is commissioning and testing of plant. Here again, the relevant chapter provides good introductory matter.

Power station capital and operating costs reveal a condensed and generally understandable form the economic efficiency. The short chapter on this subject gives guidance as to the best subdivision of costs, and the examples provided are of value in that certain of them are related to definite and fairly recent years, so that anyone wishing to proceed further with the analysis can relate the costs to the appropriate basic prices of materials of construction.

Most of the illustrations are good and interesting. Many of the line diagrams in both the steam and electrical sections are clear, and provide the reader with much better information than does the context. This is particularly the case in regard to Fig. 386, in which a typical metering arrangement for a power station and its interconnecting circuits is given. This diagram is clear, but the associated descriptive matter is relatively inadequate.

Each chapter has appended to it an extensive bibliography, but the author has shown no discrimination in his choice of the material included in these bibliographies, and has not even taken the trouble to arrange the items in a logical, convenient manner.

After studying this volume, the reviewer was irresistibly reminded of occasional visits to the Caledonian Market. There one sees heterogeneous collections of more or less useful articles, and occasionally there is something to be found of real value. There is a place in the scheme of things for both Caledonian Markets and works of the type now considered.

C. W. MARSHALL

A DICTIONARY OF PHILOSOPHY

The Dictionary of Philosophy

Edited by Dagobert D. Runes. Pp. viii + 343. (London: George Routledge and Sons, Ltd., 1944.) 27s. 6d. net.

THIS is a single volume, easy to handle and read, containing explanations of philosophical terms and outline accounts of schools of thought, special subjects and individual thinkers. It looks as though the efforts of a number of specialists had been put together in alphabetical order with little editing. Many of the articles are just right, for example, that on 'Hegelianism', and most of the definitions of Aristotelian terms. A few articles are too brief for clarity, many are too long and try to do too much.

The article on 'Scholasticism' aims at stating the name of every writer, medieval and later, so that the subject-matter of their writing is completely lost. Worst of all, it gives no references. To allot six columns to Husserl's 'Phenomenology' as against three for 'Kantianism' is out of all proportion. Symbolic logic spreads all over the place. So much so, that if an innocent biologist (who spends his life classifying) were to look up 'Class' and 'Class Concept', he would find something he could not understand until he read the text-book. After he had read it, he would discover it was no use to him. There is not even a cross-reference to 'Kind', where Mill, who has something useful to say is referred to. Political theory comes off badly. The article on 'Political Philosophy' tries to say everything and has no references, those on 'Duty', 'Right' and 'Natural Law' are scarcely adequate, that on 'Liberty' omits the political sense, there is nothing under 'Sovereignty', nor under the names Dante, Marsilius, Bodin, Hooker, Burke, Paine, Malthus. Most surprising of all, in a book from the United States, there is an article on 'Aristocracy' but none on 'Democracy'. The treatment of psychology is patchy.

Very few British philosophers appear to be known across the Atlantic. Of the thinkers of the seventeenth and eighteenth centuries, Cumberland, Joseph Butler and Richard Price are absent, and Cudworth is the only Platonist to appear. At least a dozen nineteenth and twentieth century British names are absent that are up to the standard of those included. The treatment of Greek thinkers, apart from Plato and Aristotle, is meagre and conventional. Aristippus, who is little more than a myth, appears, along with a wholly mythical grandson, but not Hippocrates, who profoundly influenced Greek and all subsequent thought. Euclid is there but not Aristarchus or Archimedes. Indian and Chinese philosophy are dealt with, how adequately the reviewer does not know. Casual inspection seems to show that in the matter of ambiguity of terms the Chinese have little to learn from Europeans.

A really ruthless editor could turn the material in this quite useful book into a very valuable work of reference.

A. D. RITCHIE

PHOTOGRAPHY WITH THE ELECTRON MICROSCOPE

A MEETING was held on November 25 at the Royal Photographic Society's rooms in London to discuss the use of photographic materials in the electron microscope. The meeting was arranged jointly by the Scientific and Technical Group of the Royal Photographic Society and the Association for Scientific Photography.

The first speaker, Mr G Parr, gave a brief description of the principles of the electron microscope based upon analogy with the well-known optical microscope. Mr L V Chilton, of Ilford, Ltd, followed with a paper written jointly by himself, Dr E M Crooks and Dr F M L Sheffield, both of the Rothamsted Experimental Station, dealing with the behaviour of a range of photographic materials in the R C A electron microscope Type B. The meeting was concluded by Dr D G Drummond, of the British Cotton Industry Research Association, who showed a number of examples of the use of the electron microscope in cotton research.

Apart from early sporadic uses of photographic materials to record the variations of energies in electron beams, probably the first industrial use was in the continuously evacuated cathode ray tube. The type of tube employing a fluorescent screen is, however, much more popular, and while special problems occur, the behaviour of the photographic material is not dissimilar from its behaviour under ordinary conditions of light exposure. The photographically effective light emitted by the screen is usually blue or green, so that no abnormal problem arises in colour sensitization. A camera of the conventional type is usually used, and the only significant divergence from standard practice is the extreme shortness of exposure time which is inevitable in the photography of rapid transient phenomena. Exposure times may be as short as 0.00001 sec, and under these conditions the relative speeds of two materials may be reversed when compared with their relative speeds as measured at an exposure time of, say, 0.01 sec.

Little work seems to have been published on the behaviour of different photographic materials to the electron beam of the continuously evacuated cathode ray tube, and with the development of the electron microscope such an investigation has become more than ever necessary. A valuable contribution has been made by the authors of the joint paper read by Mr Chilton, in which the results of tests carried out on a range of Ilford plates are described. Immediate application of the results was required for the photography of plant viruses, which give very poor contrast, and in consequence the range of materials tested was chosen for their relatively high contrast as normally measured by exposure to light.

It would be expected *a priori* that the density produced on a photographic material would depend upon the beam current and the accelerating potential. The beam current is analogous to the intensity of light and the accelerating potential to the colour. Exposures were made over a range of beam currents, and the logarithm of the value plotted against the density produced yields a characteristic curve for a given accelerating potential. By varying the accelerating voltage, a family of curves can be obtained which should show in what manner speed

and contrast vary with voltage for each material. A difficulty arises which is peculiar to electron microscope technique, as the voltage is changed, the focal lengths of the 'lenses' change and this alters the current density. The correction is calculable, but the authors used a method originally due to the National Physical Laboratory in which the brightness of the image as seen on the willemite viewing screen is compared with a comparison patch of light projected adjacent to the screen through one of the viewing ports. This enables the magnification to be altered as the kilovoltage is altered to maintain equal visual activation of the screen for a constant beam current.

Several interesting features were revealed by the results. A voltage range from 15 to 60 kv was explored, and in all the plates tested there was a marked tendency for the contrast to rise as the kilovoltage was increased. Over the range examined the relation between kilovoltage and contrast was linear, though in some cases there was an indication that at high kilovoltages a limiting contrast was being approached, as would be expected. At low kilovoltages there is a tendency for the characteristic curve to decrease in contrast at medium densities as if a relatively low maximum density was being approached. Because the contrast increases with voltage, it must not be assumed that high kilovoltages should be used for objects showing low contrast. The effective contrast of the object may itself be dependent on voltage in much the same way that an object exhibits lower contrast the higher the voltage used in the tube in radiography. The analogy cannot be pushed too far and is only given as an example. The behaviour of objects under electron bombardment may vary, so no general principles can at present be formulated, though visual observation of the willemite screen suggested in the case of plant viruses that there is a small increase of contrast with voltage. It is suggested that the decrease of contrast at lower kilovoltages is caused by the increased absorption of electrons in the outermost layer of gelatin in the photographic plate, an absorber which will be more effective the lower the energy of the electron beam. This theory suggests that the special Schumann plates in which the silver bromide crystals project through the gelatin surface (probably with a very thin covering layer of gelatin) might be worthy of trial. These plates are used for ultraviolet spectroscopy in the region where gelatin has a very high absorption.

A comparison of the relative speeds of the various photographic plates examined also yields interesting data. The exposure time given in the electron microscope was 10 sec, this figure being chosen because of the difficulty of manipulating the shutter to obtain reproducible shorter exposures. At the same time serious difficulty was experienced in maintaining constant beam current during exposures due to mains fluctuations. Both these matters might well receive attention in the design of future instruments. In addition to the electron exposures, all materials were exposed to light of various intensities for 10 sec under normal sensitometric conditions to obtain characteristic curves to light for comparison.

At any given kilovoltage the order of relative speeds, as measured by the exposure necessary to produce a density of 1.0, 2.0 or 3.0, was roughly the same for electrons as for light, except in one instance in which the sensitivity to light was substantially augmented by colour sensitization. The total range

sensitivities to electrons was much compressed compared with the range to light. At a density of 0 the total range of speeds to light was 100 to 1, whereas to the electron beam at 45 kv it was only 1 to 1. This is not surprising when it is remembered that the photographic materials in question were made primarily for exposure to light. Quite apart from colour sensitivity, the speed of a photographic emulsion to light depends on a number of factors. In general, the larger the silver bromide grains in an emulsion the greater the speed, but even at constant grain-size a wide range of speeds can be produced by the technique employed in making the emulsion. According to modern theory, the primary action of radiation in latent image formation is the release of electrons within the silver bromide crystals. Apart from the possibility of recombination, these electrons fall into 'traps' which become charged and can then add and neutralize the mobile silver ions, thus forming specks of metallic silver in their immediate neighbourhood. When the specks have grown to a certain minimum size the grain is rendered developable. It is believed that the initial size of the specks or electron traps is determined by the emulsion-making technique, the larger the specks, provided they are not sufficiently large to render the grain developable spontaneously, the greater the sensitivity to light. A delicate balance in all grains is not possible, so if few are to be spontaneously developable, the majority will require a significant number of added silver atoms to raise them to the necessary size. It is therefore probable that the absorption of a number of light quanta is necessary to render a grain developable, and control of sensitivity can be effected over a wide range by adjustment of speck-sizes during making. When the same emulsions are exposed to X-rays or high-velocity electrons, the energy of the quanta being many thousands of times greater, it may be that the absorption of a single quantum is sufficient to provide enough electrons to enable even relatively insensitive specks to reach dimensions sufficient to render the grain developable.

This argument is necessarily only given in brief, but it suggests that sensitivity to light is much more dependent on the condition of the sensitive specks than is sensitivity to electrons or X-rays. Sensitivity to high-energy quanta would be expected to depend on the probability of a quantum being absorbed, and thus more on grain size. It is indeed possible to produce emulsions relatively very sensitive to X-rays and at the same time relatively insensitive to light, and such materials are marketed for use without fluorescent screens.

Returning to the results communicated by Mr. Hulton, he and his co-authors endeavoured to find the relation between photographic speed and kilovoltage of the electrons. This was complicated by the fact that the reference standard between the different kilovoltages was the brightness of the Ilford viewing screen. Some idea of the efficiency of the screen in converting electron energy into light energy was obtained, and it was then possible to make a rough correction to the exposure axis so that direct comparison of speed at different kilovoltages was possible. This revealed that the variation with kilovoltage of speed as measured by the density produced by an arbitrary standard exposure was different for the various plates examined. In some there is little change over the range of kilovoltages used, in others the photographic speed increased with kilo-

voltage and reached a maximum near the upper limit of the range, and again in others there was a steady rise over the whole range.

These results show clearly the necessity for a fuller investigation, and it is to be hoped that the authors will be able to extend their work to cover a wider range of materials and conditions. Other workers have published results of a similar nature, some of which are in general agreement with the results discussed here. Substantial disagreement between results obtained by different workers is not unusual where photographic materials are concerned and should not be taken to indicate anything but the uniqueness of every photographic emulsion type. Special mention may be made of work published by von Borries (*Physikal. Z.*, 43, 190, 1942) using Agfa and Perutz plates, which shows substantial qualitative agreement in all points with the Ilford plates used in the tests described.

There is no doubt that there is much to be learned about the technique of electron micrography of different subjects, and the selection of the most suitable photographic material and its treatment. It must also be remembered that manufacturers have not yet made any attempt (or at any rate no outwardly apparent attempt) to make plates specially suited to the needs of electron microscopy. Such a development may be expected when more is known of the requirements and a demand is made for special materials, just as has occurred in the case of X-rays, and more recently in the photography of the cathode ray tube screen.

The authors of the papers who contributed to a well-attended and most successful afternoon meeting are to be congratulated on arousing interest in such an important subject, and making so valuable a contribution, which it is hoped will whet the appetite of other workers in the field who are fortunate enough to have the necessary equipment for further investigations. The full text of the papers is to be published in the *Photographic Journal* early this year.

STRUCTURE OF DIAMOND

DIAMOND is generally thought to be one of the most perfect crystals occurring naturally. Its atomic structure was first investigated in the very early days of X-ray crystal analysis. It turned out that the atoms of the crystal were arranged on two interpenetrating face-centred cubic lattices, the corner of one cube lying one quarter of the way along the cube diagonal of the other. Whether the resulting crystal possessed full octahedral symmetry or was of the lower tetrahedral type, a question on which crystallographers were divided, could not be settled by the additional X-ray evidence. Some ten years ago, new interest in the structure of diamond was aroused by the work of Robertson, Fox and Martin¹, who showed that the infra-red absorption and ultra-violet transparency of diamonds placed them in two classes. Of the two types, the first and commoner was opaque to both infra-red and ultra-violet radiation, while the second, Type II, is rare and is transparent to these radiations. The more recent X-ray investigations of Lonsdale and Smith² have shown that although the two types are structurally identical on an atomic scale, there are abnormalities in the diffraction patterns of Type I diamonds which suggest some kind of 'mosaic' structural difference in the two

types Dr Lonsdale's observed effects are in fact very similar to the kind of abnormality observed in the X-ray spectra of age-hardened alloys and alloys with high magnetic coercivity, they suggest a laminated structure

There has recently appeared in India a "Symposium of Papers on the Structure and Properties of Diamond" inspired by an idea due to Sir C V Raman³. The symposium runs to more than 150 pages and contains seventeen papers by Raman and his colleagues. The fundamental idea, contributed by Raman, is that there are four structurally possible arrangements of carbon atoms which are all in agreement with X-ray data. Two of these, which, following Raman we may label *Td* I and *Td* II, will give a crystal with tetrahedral symmetry, and two, *Oh* I and *Oh* II, will produce the full octahedral symmetry. The two tetrahedral types are physically identical but geometrically different; the octahedral types are physically distinct and might have slightly different lattice parameters.

Raman then supposes that something in the nature of twinning or parallel growth of these different but closely allied types occurs. Twinning of the two *Td* types would be difficult to detect as it would produce little, if any, internal strain on the crystal. But union of a *Td* with either of the *Oh* types might be detectable as a result of strains due to slightly different lattice spacings. Twins of the two *Oh* types might also produce observable strains. Raman thus suggests that there are more than the two types recognized by Robertson, Fox and Martin, and that some diamonds may be 'mixtures' of the different types. The position can perhaps be best summarized in tabular form, the lower part of the table is derived from material taken from the Indian symposium.

Type I		Type II
Numerous Infra-red absorption Opaque to ultra-violet Blue luminescent Abnormal X-ray spectra		Rare Transparent to infra-red Transparent to ultra-violet Not luminescent Normal X-ray spectra
Tetrahedral <i>Td</i> I or <i>Td</i> II, physically identical <i>Birefringence Patterns</i> Non-isotropic (but anisotropic according to R F and M) <i>Luminescence Pattern</i> Uniform blue luminescence <i>X-ray Topography</i> Uniform intensity of reflexion <i>Ultra-violet Transparency Patterns</i> Opaque with faint blue luminescence or partially transparent with strong blue luminescence <i>X-ray Reflexion</i> Intensity increases with blue fluorescence <i>Photoconductivity</i> Small	Mixed Twins of <i>Td</i> and <i>Oh</i> Related to structure Blue and yellow pattern of lines and dark patches Mixture of uniform regions with streaks related to structure Patches of opaque and transparent regions, related to structure Moderate	Octahedral <i>Oh</i> I and <i>Oh</i> II, physically distinct Related to structure (but isotropic according to R F and M) Parallel strips of low intensity Transparent Great intensity in discrete small-scale mosaic structure Large

The evidence in support of Raman's theory is really supplied by those experiments which indicate that a particular diamond is not homogeneous. These are the experiments on birefringence (where the results are at variance with the observations of Robertson,

Fox and Martin), luminescence and ultra-violet transparency patterns. The item in the table "X-ray Topography" deserves some fuller explanation. Under this title G N Ramachandran describes an ingenious method of obtaining an X-ray image of a crystal flake in which variations of reflecting power are recorded. Such variations appear to be related to the ultra-violet transparency and other properties of the diamonds.

The symposium is not wholly devoted to a demonstration that four different types of diamond do exist. There are several papers dealing with the properties without reference to the particular type. R S Krishnan contributes a paper on the Raman spectrum of diamond, based on Raman's interpretation of the dynamics of the crystal lattice, while B Daya applies the same ideas to the evaluation of the specific heat of diamond. An examination of the magnetic susceptibility by A Sigamony shows that this property is not structure sensitive and that it does not change when a fluorescent diamond is irradiated with an intense beam of light.

The symposium concludes with an interesting paper by S Ramaseshan describing the external form and surface markings of twenty-nine diamonds from Pannu in their natural state. Considering the perfection usually ascribed to diamonds, the marked curvature of the faces of natural crystals is not without interest.

The authors who have contributed to the symposium have been fortunate in having at their disposal a collection of 310 diamonds made by Sir C V Raman. This wealth of material has been an undoubted help to them, and contributes effectively to the value of the work they have carried out. There is evidently an interesting problem here, not yet completely solved, one key to it lies in a more complete understanding of the abnormal X-ray reflexions recorded by Lonsdale and Smith. G D PRESTON.

- ¹ Robertson, Fox and Martin, *Phil. Trans. Roy. Soc., A*, **232**, 462 (1934), *Proc. Roy. Soc., A*, **157**, 579 (1936)
² Lonsdale and Smith, *Nature*, **148**, 112 (1941)
³ Raman and others, *Proc. Indian Acad. Sci., Bangalore*, 189-342 (1944)

SOIL CONSERVATION IN THE ANGLO-EGYPTIAN SUDAN

By E N CORBYN
Formerly Governor of Khartoum

IN December 1942, a committee was appointed by the Governor-General of the Anglo-Egyptian Sudan to consider the problem of soil conservation in the Sudan, it was constituted as follows. Dr J D Tothill, director of agriculture and forests, Lieut.-Colonel C P Fisher, director of the veterinary service, Mr J Smith, chief conservator of forests, Mr G Andrew, Government geologist, and Messrs G M Hancock and B Kennedy-Cooke, Sudan Political Service. The Committee's report has just been issued.*

The terms of reference of the Committee were (a) To report on the present situation in the Sudan with regard to soil erosion and desiccation and the

* The Report of the Soil Conservation Committee, Sudan Government, 1944. Pp. 161+12+2 maps. (Khartoum: McCorquodall and Co (Sudan), Ltd., obtainable from Sudan Government London Office, Wellington House, Buckingham Gate, S W 1.) 2s 6d net.

availability of rural water supplies for the human and animal population (b) To make recommendations in respect of any of the above matters and of any measures of legislation or taxation which may be required for the carrying out of such recommendations (c) To draw up a programme of work covering a stated period of years for the implementation of the recommendations (d) To provide estimates of the capital cost of carrying out the programme and the future maintenance costs involved

The findings of the Committee are securely based on the best expert scientific knowledge available to the Government, and the standard of the Sudan in such matters is high. This powerful effort to lay down the broad lines on which, over a territory of a million square miles out of the eleven and a half millions which constitute Africa, the three-fold dangers of soil erosion, devegetation and desiccation will be met, deserves the flattery of imitation by any governmental authority in that continent. Now widespread is the desire of African Governments to deal with these menaces adequately was shown by the success of the International Commission set up in London to study them in 1942 by the Royal African Society, under the chairmanship of Prof. P. Stebbing, in which the cordial co-operation was obtained of the French and Belgian African administrations, and to which the Dutch Government contributed the fruits of its Asiatic experience.

The Sudan is particularly well placed to state whether there is a 'desert creep' of the Sahara southwards in its area, as it borders upon the south-eastern tip of the great Libyan Desert. The findings of the Committee are on the whole reassuring on this point, but this may be due in this region to something like a piece of geological good fortune, namely, the oasis, from the Sahara southwards to about lat. 30° N., of a great 'blanket' of sand, dating from recent times, which 'has been static or fixed for several thousands of years . . . and is everywhere holed or fixed by vegetation grading from lightest to heskanit [a tough grass] depending on local rainfall . . . Being permeable in structure and fixed position it prevents erosion from taking place' in its sand forms, fortunately, a cultivable soil.

The clay plains south of this great area of 'continental' sand, and the clay plains of the major portion of the country in general, do not share the comparative immunity of the sand area from erosion, and their problem is similar to that of other parts of the Sahara.

The Committee does not consider that there has been any great alteration of climate in the direction of desiccation within historic times—say, the last 100 years. But it finds abundant evidence of fluctuations of both wet and dry periods in previous geological times. It concludes, therefore, that such fluctuations and erosion as have taken place, and are taking place, are due to the activities of human beings and their animals, and can consequently be rolled back by bringing about changes in these activities sufficient to restore damage and prevent further deterioration.

The Committee's survey of existing conditions in the Sudan showed many and serious examples of soil deterioration as at present taking place. Sheet erosion was found to be occurring in many places in all country of southern Kordofan and of Equatoria, and near the gullied land of the Blue Nile. Soil erosion was noted as common and locally

important in Equatoria, along the banks of the Blue Nile, Dinder and Atbara Rivers, in the hills of Kordofan, and in the coastal range of Red Sea hills. Soil deterioration due to overgrazing, and over-cropping was found to be common in all the thickly populated areas.

Deterioration of forest watersheds due to fires and grazing was observed as taking place in the Red Sea hills, in the hills of southern Kordofan and of the southern Fung and eastern Upper Nile districts, and in the hills and mountains of Equatoria, where it is sometimes also due to agricultural development of the heads of valleys.

Spoliation of agricultural land by silt dune formation was found to be taking place in the delta of the Khor (River) Baraka around Tokar. Spoliation of rain-watered agricultural land by out-of-season fires was noted as common on the clay plains of Kassala, Blue Nile, Upper Nile and Kordofan.

Finally, towns and village peripheries were found to be deteriorating rapidly all over the country, owing to over-cultivation and over-grazing of the surrounding areas, and excessive cutting of trees for firewood in the neighbourhood of towns.

An extensive programme of more than fifty items, covering different danger-points spread over all the eight provinces of the Sudan, is put forward by the Committee, to some thirty of which a priority classification is given as matters of urgency.

The remedies recommended fall under main headings as follows:

(1) Methods of rain and flood-water control: gully plugging, contour terracing, protection of heads of catchment areas

(2) Forest protection: reservation of forest areas to an increased extent, protection from fire, re-afforestation, control of fire-wood supplies

(3) Treatment of cultivable rain-watered grasslands: control of annual burning methods, fire protection

(4) Control of town perimeters, including reservation of areas for the growing and supply of fodder for domestic animals, and for fire-wood, whether from near or distant sources, control of village planning, so far as necessary to ensure conservation and the best use of the soil of village areas, control of the grazing habits of nomads, so far as necessary to avoid deterioration in the soil of grazing areas

Two great merits of the report are that its recommendations apply these remedies to definite schemes at definite places, and that financial estimates of the cost of these schemes on a basis of a five-year experimental period are worked out and provided, totalling in the first instance to a sum of £300,000, spread over five years, to be at the disposal of a board appointed for the purpose.

A considerable part of the Committee's recommendations falls under the heading of improvement of water supplies, a most important matter in so arid a country, and one which in itself will relieve the strain on soil surrounding the water-points which exist already in agricultural and grazing areas.

The Sudan Government has accepted the main recommendations of the Committee, and will make the necessary funds available for the five-year trial period envisaged. It has appointed a Water Supplies and Soil Conservation Board to administer the funds provided and to take executive action on the schemes proposed.

NEWS and VIEWS

Prof. Eric Ashby Australian Scientific Attaché to the U.S.S.R.

PROF. ERIC ASHBY, professor of botany in the University of Sydney, has been appointed scientific attaché, with rank of counsellor, to the Australian Legation in Moscow, for about a year. Prof. Ashby's appointment has been made in order to establish contact with leaders of science in the U.S.S.R., and particularly with those working on problems of mutual interest to that country and Australia. Since Prof. Ashby's appointment to the chair at Sydney in 1938, he has established himself in Australia as a first-class man of science and organizer. He was chairman of the Australian National Research Council during 1940-42 and is honorary scientific adviser to the Australian Department of War Organization and to the Scientific Liaison Bureau. He is well acquainted with the scientific resources of Australia, for in 1942 he carried out a survey of them for the Prime Minister. In his own botanical researches he has made a special study of crop development. Therefore it is clear that the Australian Government has made a very wise choice for its first scientific attaché to the U.S.S.R. Prof. Ashby is now staying in Britain for a short time, before proceeding to Moscow. It is possible to get in touch with him by communicating with the Editors of *Nature*.

Tropical Medicine at Liverpool

LIEUT.-COLONEL B. G. MAEGRAITH, who is at present in charge of the Army Malaria Research Unit, has succeeded, at the age of thirty-seven, the late Prof. Warrington Yorke in the Alfred Jones chair of tropical medicine at the Liverpool School of Tropical Medicine. After graduating at the University of Adelaide in 1930, Prof. Maegraith went to Oxford as a Rhodes Scholar and there took his B.Sc., D.Phil. and M.A. He was awarded a Bert Fellowship and became fellow of Exeter College and tutor in physiology. Later, he acted as dean of the Oxford University Medical School. Earlier in the War he served as consulting physician and assistant director of pathology in the West African Command and there studied, with Brigadier G. M. Findlay and N. H. Martin, the factors present in tissues and blood which may produce or inhibit lysis of the blood cells. In Australia, Prof. Maegraith had made a hematological study of the aborigines, and later he studied hemolysis.

Physical Anthropology at Oxford

DR. J. S. WEINER has been appointed to the readership in physical anthropology at the University of Oxford. Before the War he was engaged in a study of the physiological characteristics of the Bantu people, with special reference to heat tolerance and vitamin C nutrition. More recently he has been concerned with war-time problems of acclimatization. Dr. Weiner's appointment marks a new orientation in the development of physical anthropology in Great Britain. While in the past the subject has been mainly confined to the statistical study of purely morphological variations in skeletal dimensions, its future development is likely to be concerned with such practical problems as racial variations in physiological efficiency.

Harrison Memorial Prize for 1944

THE Selection Committee, consisting of the president of the Chemical Society, the Royal Institute of Chemistry, the Society of Chemical Industry and the Pharmaceutical Society, has awarded the Harrison Memorial Prize for 1944 to Dr. Leslie F. Wiggan of the University of Birmingham, in recognition of his researches on transformation products of the hexose sugars. His originality and resource, combined with exceptional experimental skill in these investigations, have opened new fields of theoretical interest. Much of this work holds promise of practical development along novel lines.

U.S. National Academy of Sciences

Election

THE following elections to the U.S. National Academy of Sciences were made at the 1944 Annual Meeting.

Members. Prof. Thomas Addis, professor of medicine, Stanford University Medical School, San Francisco, California; Dr. Charles Armstrong, surgeon in the United States National Institute of Health, Bethesda, Maryland; Prof. Philip Bar, professor of medicine, Johns Hopkins University School of Medicine, Baltimore, Maryland; Prof. G. W. Beadle, professor of biology, Stanford University, California; Prof. Hans A. Bethe, professor of physics, Cornell University, Ithaca, New York; Prof. Edward U. Condon, Westinghouse Research Laboratory, East Pittsburgh, Pennsylvania; Dr. George O. Curme, jun., Carbide and Carbon Chemical Corporation, New York, N.Y.; Dr. Hugh L. Dryden, National Bureau of Standards, Washington, D.C.; Dr. Carl O. Dunbar, Yale University, New Haven, Connecticut; Prof. Vincent du Vigneaud, professor of biochemistry, Cornell University Medical College, New York, N.Y.; Prof. James Franck, professor of physics, University of Chicago, Chicago, Illinois; Prof. Reynold C. Fuson, professor of chemistry, University of Illinois, Urbana, Illinois; Prof. Edwin Bret Hart, professor of agricultural chemistry, University of Wisconsin, Madison, Wisconsin; Prof. Seaver Hecht, professor of zoology, Columbia University, New York, N.Y.; Mr. Alfred H. Joy, Mt. Wilson Observatory, Pasadena, California; Prof. Esig Signius Larsen, jun., professor of petrology, Harvard University, Cambridge, Massachusetts; the Rt. James B. Macelwane, *S.J.*, director of the Institute of Geophysics, St. Louis University, St. Louis, Missouri; Prof. Leonard A. Maynard, professor of animal nutrition, Cornell University, Ithaca, New York; Prof. Barbara McClintock, Department of Genetics, Carnegie Institution of Washington, Cold Spring Harbor, Long Island, New York; Prof. C. Moore, professor of zoology, University of Chicago, Chicago, Illinois; Prof. Alfred S. Romer, professor of zoology and curator of vertebrate paleontology, Harvard University, Cambridge, Massachusetts; Prof. Louis B. Slichter, professor of geophysics, Massachusetts Institute of Technology, Cambridge, Massachusetts; Prof. Lee I. Smith, professor of organic chemistry, University of Minnesota, Minneapolis, Minnesota; Prof. Don M. Yost, professor of inorganic chemistry, California Institute of Technology, Pasadena, California; Prof. Oscar Zariski, professor of mathematics, Johns Hopkins University, Baltimore, Maryland.

Foreign Associates. Sir Edward Bailey, director of the Geological Survey of Great Britain, P.

Leopold Ruzicka, Department of Organic Chemistry, Institute of Technology, Zurich

Presentation of Medal and other Awards

At the same meeting, the following medal and other awards were presented

Daniel Giraud Elliot Gold Medal and Certificate awarded annually to the author of an outstanding paper, essay or other work on some branch of zoology or palaeontology, to Prof Malcolm R. Irwin of the University of Wisconsin, for his work "Immunogenetic Studies of Species Relationships in Colymbidae" (*J. Gen.*) (for 1938), Prof John H. Northrop, Rockefeller Institute for Medical Research, Princeton, New Jersey, for his work "Crystalline Enzymes: the Chemistry of Pepsin, Trypsin and Bacteriophage" (Jessup Lectures, Columbia University Press) (for 1939), Prof William B. Scott of Princeton University, for his work "The Mammalian Fauna of the White River Oligocene. Part IV. Artiodactyla" (*Trans. Amer. Phil. Soc.*) (for 1940).

Mary Clark Thompson Gold Medal (awarded annually for the most important services during the period in geology and palaeontology), to Prof Edward V. Berry of Johns Hopkins University, for outstanding contributions to knowledge of the Mesozoic and Cenozoic floras of North, Central and South America, and the Antilles, in their relations to stratigraphy, the ecology and geographic distribution of past floras, and the evolution of the different groups of flowering plants (for 1942), Dr George G. Simpson of the American Museum of Natural History, for his outstanding contributions in the field of vertebrate palaeontology, including a study of the Mesozoic mammals, and distinction as a field collector, systematic palaeontologist and original thinker on broad problems of evolution (for 1943), Dr William J. Arkell, formerly of New College, Oxford, now with the Ministry of Transport, for his outstanding contributions to palaeontology and geology, including extensive studies of stratigraphic units of different geologic age in widely separate regions, British Jurassic faunas, the history of the region of Great Britain in Jurassic times, palaeoecology, the late Tertiary history of the Nile region, and other services, all leading to important publications.

Ordinance Distinguished Service Award of the Ordnance Department, United States Army. This was presented to the National Academy of Sciences in recognition of outstanding and meritorious scientific services, in war and peace, for the development, manufacture and maintenance of Ordnance material. The award was authorized on July 20, 1944, and was presented by Major-General G. M. Barnes, chief of the Research and Development Service Ordnance Department.

Textile Industries at the University of Leeds

THE steady expansion of the wool textile industry of Great Britain up to 1914 was based on the lead given by early textile inventors, aided by the unique skill acquired by successive generations of craftsmen. A great structure had been erected on a foundation of simple empiricism, but the industrialist was still applying imperfectly understood processes to a material of unknown composition and properties. As the training of textile technologists was in the hands of craftsmen with neither scientific training nor research experience, there could be no hope of breaking the vicious circle of empiricism until scientific

workers were persuaded to make a study of textile materials and processes. A first step in this direction was taken by the Department of Textile Industries of the University of Leeds in 1919, when a lecturer in textile chemistry was appointed. From this small beginning it was hoped in time to build up such a body of knowledge that textile technology would be transformed into an applied science. This, in turn, was intended to provide the Department with a staff of technologists having scientific as well as technical qualifications, to create a bond between science and the industry by giving its recruits a combined training in science and technology, and to provide industrial research laboratories with scientific men trained in the methods of research on textile materials and processes.

All these aims have now been achieved, owing to the rapid expansion of the research section of the Department since 1928, when the Worshipful Company of Clothworkers made a grant of £3,000 a year for research purposes. The grant made it possible to appoint a lecturer (now reader) in textile physics (Dr W. T. Astbury) and two research assistants, besides providing a number of scholarships and fellowships for research workers drawn from the science departments of the universities. Dr Astbury's work has since been supported by the Rockefeller Trustees, and that of the Textile Chemistry Section by a number of organizations and firms. Both the Textile Physics and Textile Chemistry Sections have been responsible for important advances in pure and applied science, and, excluding staff, there are now twenty-seven research workers in the Department. Its interests cover the whole field of high polymers, from cellulose and the proteins to plastics and synthetic fibres, from biology to technology. A craft has been carried to the forefront of the applied sciences in a single generation.

Needless to say, such rapid expansion has brought difficulties in its train. In a Department which was originally non-scientific, the difficulty of providing accommodation for research workers was always acute, and is now intensified by the needs of the technological staff. Every spare room has been converted into a laboratory, an army hut has been brought into service, and temporary accommodation has been provided in one of the laboratories of the sister Department of Colour Chemistry and Dyeing. The time has now come to consolidate the position, to collect together scattered groups of research workers and to provide research facilities for the technological staff. Two schemes of reorganization are proposed at a total cost of £22,000, towards which Messrs. Imperial Chemical Industries, Ltd., Dyestuffs Division, and the Tootal Broadhurst Lee Co., Ltd., have each made donations of £2,500.

The International Setting of Reconstruction

UNDER the general title "Looking Forward", the Royal Institute of International Affairs is publishing a series of pamphlets on the international aspects of reconstruction, which are intended to stimulate thought and discussion, and to aim at presenting problems rather than to solve them. In the first of these, "Britain and the World" (Pp 60. 1s net), the Hon. H. A. Wyndham gives an outline of reconstruction problems, the general background in Europe and the Middle East, and such factors as freedom of trade and migration in the nineteenth century and up to 1939 are discussed in the first part, and Britain's position in the post-war world is considered in the

second part. Some home problems, such as industry and its organization and control, demobilization, exports, social insurance, housing and agriculture, health and educational services are briefly indicated in the third. The second chapter indicates some of the implications of the Atlantic Charter in such matters as relief and rehabilitation in Europe and the Middle East, the significance of the Hot Springs Conference, the potentialities of the Middle East Supply Centre, the problem of Germany and the special problems of the British Empire, such as the co-ordination of foreign policy and defence and trends in colonial welfare and development. Although necessarily sketchy, the pamphlet succeeds in indicating the relation of particular problems to the larger issues, and the problems of home and international policy, on the solution of which Britain's economic stability, social security and future prosperity depend.

Typhus in Guatemala

THE July issue of the *Boletín de la Oficina Sanitaria Panamericana* contains an account of an outbreak of typhus by Dr Julio Roberto Herrera, head of the Section of Epidemiology of the General Health Office of Guatemala. He stated that he received on April 3, 1944, a notification of 198 cases of an infectious disease, which turned out to be typhus, in a home for the insane, a general hospital and a penitentiary. There were altogether 198 cases with 63 deaths. The case fatality for the home for the insane was 26.10 per cent. Preventive measures included quarantine of the foci, restriction of visits, disinfection and disinsectization of the hospitals, barracks, etc., verification of definite and suspected cases by public health laboratories, visiting of all contacts, immunization of exposed staff, examination of autopsy specimens, organization of a national disinfection station, education of the public by the Press, radio, etc., isolation of cases and supervision of hospitals and welfare stations.

British Dragonfly Records

MISS CYNTHIA LONGFIELD, British Museum (Nat. Hist.), Cromwell Road, London, SW 7, writes "As I shall be revising for publication, in the very near future, the records on distribution of all the British dragonflies, I shall be most grateful if all collectors, who have not done so already, will send me their lists of localities, including approximate status, of dragonflies identified up to the end of 1944. Observations on habitats, definite proof of breeding and methods of oviposition will be most valuable. All help will be gratefully acknowledged."

Royal Institution · Graduate Memberships

THE first three of the graduate memberships recently established by the Managers of the Royal Institution for recent graduates, of either sex, of any university in the British Empire who have obtained first- or second-class honours in any scientific subject, have just been awarded. The recipients are: Miss June M. Broomhead, who gained a major scholarship in 1941 and a research scholarship in 1944 at Newnham College, Cambridge, and was placed in Class II (1) in the Natural Sciences Tripos in physics, 1944; Mr. Robert B. Morrison, who took first-class honours in physics in the University of London, 1944, and is now University demonstrator at King's College; and Mr. Anthony P. Waterson, who took a first class in Part I of the Natural Sciences

Tripos, Cambridge, 1943, and in Part II (biochemistry), in 1944. He is studying medicine at the London Hospital.

Royal Aeronautical Society · British Empire Lecture

THE Council of the Royal Aeronautical Society has recently completed arrangements for the founding of a British Empire Lecture. The Lecture, on any aeronautical subject approved by the Council, will be delivered annually in September in London, by a lecturer chosen in alternate years from the British Dominions and Colonies and Great Britain. The Society, by founding the Lecture, is anxious to encourage new ideas and new points of view from all parts of the British Empire, and to make the lecture second in importance only to the Wilbur Wright Memorial Lecture. The British Empire Lecture will have a premium of £50 attached to it, and in the case of lecturers coming from the Dominions and Colonies an allowance up to £100 will be paid towards the lecturer's expenses. It is proposed to hold the first lecture in September 1945, and suggestions for lecturers should be received by May 31, 1945, at the latest.

University of London Appointments

DR L. S. PENROSE has been appointed to the Galton chair of eugenics tenable at University College. Since 1939 he has been attached to the Provincial Department of Health, Ontario, Canada, and in addition is a physician at the Ontario Hospital, lecturer in psychiatry in the University of Western Ontario, and medical statistician for the Province.

DR C. RIMINGTON, who has been on the staff of the National Institute for Medical Research since 1937, has been appointed as from May 1 to the University chair of chemical pathology tenable at University College Hospital Medical School.

Announcements

WE regret to announce the following deaths:

The Earl of Balfour, P.C., chairman of the Cambridge committee of the Commission on the Universities of Oxford and Cambridge, on January 14, aged ninety-one.

Sir Thomas Barlow, Bart., K.C.V.O., F.R.S., president in 1910-15 of the Royal College of Physicians, on January 12, aged ninety-nine.

THE Committee of the Athenæum has elected the following, under the provisions of Rule II of the Club, which empowers the annual election by the Committee of a certain number of persons of distinguished eminence in science, literature or the arts, or for their public services: the Right Hon. Lord Catto of Cairncross, governor of the Bank of England; Sir Bennett Melvill Jones, Francis Mond professor of aeronautical engineering, University of Cambridge; the Hon. John Gilbert Winant, ambassador of the United States to the Court of St. James's.

DR DELLEPIANE RAWSON, an eminent plastic surgeon in the Argentine, has arrived in Britain for a six months visit arranged by the British Council. Dr. Rawson, who is head of the special ward for plastic and restorative surgery at the Hospital Rawson, Buenos Aires, and associate teacher at the Faculty of Medicine, will be working with Sir Harold Gillies in the Emergency Medical Service Plastic Surgery Unit at Park Prewett Hospital, Basingstoke.

LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications.

Photographic Record of Follicular Keratosis

In the treatment of some types of skin disease, during which progress may be relatively slow, only slight changes in the appearance of the skin occur between successive examinations, even when these are spaced several weeks apart. This makes the effect of the treatment difficult to observe visually. It has been suggested that a photographic method of recording the progress in such cases may be of value.

In the study of follicular keratosis (folliculosis), a special photographic technique is required to give a sufficiently good rendering of the texture of the skin, as in this case the irregularities of the surface are small in size, and do not differ appreciably in colour from the surrounding area. It is also necessary to devise an apparatus which will enable such a technique to be applied with all conditions kept constant so that any changes in the appearance of the skin will be shown readily.

Various means of recording folliculosis photographically have been tried in this Laboratory, including the use of ultra-violet and infra-red, the most promising results so far have been obtained by the following methods:

(a) By illuminating the surface with a small point source, the light from which strikes it at a grazing angle of incidence, so that sharp shadows of the elevated areas on the skin are produced.

(b) By illumination at a more nearly vertical angle of incidence. In this case, as the shadows are much less pronounced, the film must be developed to a high degree of contrast to show the markings on the skin.

The two methods appear to be complementary, as certain details are shown up in one case which may not be seen in the other.

A portable apparatus has been developed using a Leica camera fitted with an extension tube to enable close-up photographs to be taken, by both methods of illumination. While the apparatus has been designed to minimize the relative movement between

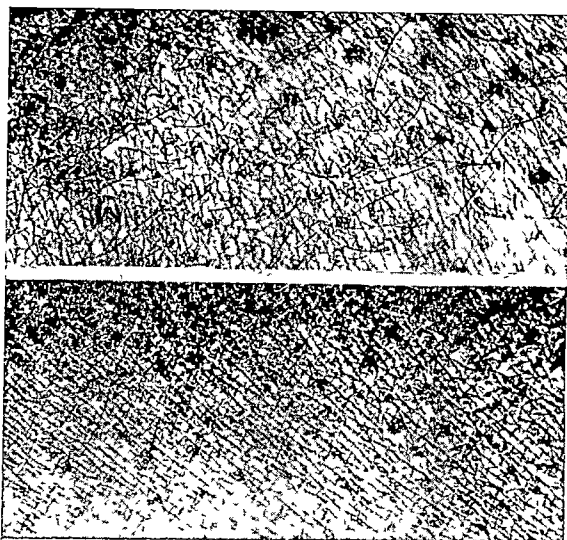


Fig 2 PHOTOGRAPHS OF FOLLICULAR KERATOSIS ON DARK SKIN. ABOVE, FLAT LIGHTING, BELOW, OBLIQUE LIGHTING $\times 16$

the patient and the camera, nevertheless the exposure time should be as short as possible to prevent the definition from being impaired by any involuntary movements of the patient. The camera lens must also be stopped down to a small aperture to give an adequate depth of focus, as the surface of the arm or leg under observation is usually rounded. For both reasons, a high level of illumination of the skin is required.

A Mazda 250-watt box type ME lamp (a mercury vapour lamp with a small source of high brightness) is used as the source for oblique illumination, while a 250-watt photo-flood lamp mounted in a reflector provides the illumination for the second method. Satisfactory exposures are obtained with 0.5 sec at an aperture of $f/18$ with a panchromatic film having a speed of 23° Scheiner with oblique illumination. With the photo-flood lamp, which is about 6 inches from the surface of the skin, a similar exposure is quite satisfactory, using in this case Kodak Microfilm.

The conditions of lighting on the skin of the patient are kept constant by fixing the lamps in relation to the camera. A rectangular aperture covering the whole field of view of the camera is attached to it at such a distance from the lens that all within the field is in accurate focus. The lamps, camera and aperture are mounted on a framework which can be adjusted into any position. In using the apparatus, it is arranged so that the aperture surrounds, and its sides touch, the area of skin which is to be photographed.

The apparatus is shown in operation in Fig. 1, and some typical photographs taken with the two methods of lighting are shown in Fig. 2.

The experiments have been carried out at the request of Dr Magee in collaboration with Dr Hawes and Dr Stannus, working for the Ministry of Health, who have kindly allowed the photographs to be published. Acknowledgement is also due to Mr. H. Warren, director of research, B.T.H. Company, for permission to publish this note.

H. K. BOURNE.

Research Laboratory,
British Thomson-Houston Co., Ltd.,
Rugby Nov. 10.



Fig 1 APPARATUS FOR PHOTOGRAPHY OF FOLLICULAR KERATOSIS

Phase Difference Microscopy

I HAVE read with much interest the description by Mr. O W Richards of his own and his colleagues' recent work on Zernike's phase contrast method. Everyone who is interested in the microscopical observation of living cells should be grateful to him for having once again directed attention to its value as applied to microscopy. It possesses the advantage over ordinary trans-illumination that fine unstained structural detail is seen in greatest contrast by focusing exactly on the specimen, so that we may expect a closer geometrical correspondence between the appearance seen and what is 'really there'.

During the past eight years, Zernike's method has been regularly used in this Laboratory by Dr C R Burch and by others whom he has interested and helped, both as a test for the accuracy of mirrors intended for astronomical and other purposes¹, and as applied to microscopy, including the microscopy of living cells².

Interesting new possibilities in the preparation of phase-contrast configurations, for example disks and strips, have lately been opened up by the development of the modern technique of controlled evaporation *in vacuo*. By this process, a transparent layer can be deposited on a thin glass plate of such a thickness as to increase by one quarter of a wave-length the retardation of yellow light passing through the plate. By drawing a fairly sharp stylus across this layer, we can remove the soft coating from a narrow strip of the glass without damaging the glass surface. The result is a 'phase-advancing strip' which can be used for phase-contrast testing in the same way as the phase-retarding disks and strips so ingeniously prepared by Dr Burch.

A relatively easy way of producing such coatings is to leave the glass plate in a lens-blooming chamber, such as is now used by some optical firms, during five or six consecutive runs. This builds up a layer of approximately the desired thickness.

In an investigation into phase-contrast diffraction theory which I hope to publish shortly, I have shown that considerable variation can be allowed in both the thickness of the layer and the width of the strip without seriously reducing the efficiency of the method. No doubt this is one reason why the method is so successful in practice.

E H LINFOOT

H. H Wills Physical Laboratory,
University of Bristol.

Dec. 1

¹ Burch, C R, "On the Phase-Contrast Test of F Zernike", *Mon Not Roy Ast Soc*, 94, 384 (1934). "On a Zonal Zernike Test for Paraboloids", *Mon Not Roy Ast Soc*, 95, 548 (1935).
² Burch, C R, and Stock J P P, "Phase-Contrast Microscopy", *J Sci Instr*, 19, 71 (1942).

Age of the Saline Series in the Salt Range of the Punjab

OUR evidence for the post-Cambrian age of the Saline Series, based upon microfossils in the rock-salt and marl, was already clear and ample^{1,2}. It has since been greatly reinforced by the discovery, both at Khewra and Warchha, of similar fossils in dolomites, dolomitic limestones and shales belonging to the Series, which do not admit of the remotest suspicion that any foreign matter was washed in, faulted in or caught up by later earth movements.

Some of these more recent finds were reported to *Nature* in a communication dated July 21, but on the receipt, soon afterwards, of the issue containing the interesting note by Dr G M Lees³, we withheld publication until we should be in a position to offer fuller data, if possible after examining the Persian material kindly sent by him. These specimens have not yet arrived, but meanwhile the *in situ* nature of our Khewra and Warchha material has been fully confirmed by Dr H L Chubb, who very kindly accompanied us to the Salt Range early in October this year, and who proposes to write a geological note on the localities in question.

(a) *Rock-salt and kallar*. Of the samples of rock salt plus kallar newly collected, only two have yet been examined (coll. Sahni, Oct 3, 1944, Mayo Min. Khewra). K4, from the Middle Pharwala seam in Chamber 19, showed several pieces of conifer wood with well-defined bordered pits, and some woody fibres. K5, from the Buggy seam in Pillar 47-48 43 Incline, 2nd Sub-level North, brought forth a cuticle with two stomata, several shreds of wood and some continuous remains.

The winged insect from the Warchha marl, mentioned in a previous communication⁴, has since been identified as a new extinct species of *Charonimus* *C. primitivus* M S Mani⁵. This genus of Diptera has not so far been found in the Indian strata.

(b) *Dolomites and dolomitic limestones*. From the Warchha mine Mr B S Lamba had sent to one of us a specimen of compact saline dolomite (Lamba, No 7 Warchha, July 1944) taken from a stratum within the Saline Series as exposed in the New Low Level Tunnel, at least 1,500 ft from the entrance. Treated with dilute hydrochloric acid, it released numerous shreds of pitted woody tissues, among them two pieces of conifer wood with bordered pits and medullary rays. A little dilute safranin placed on a thin slice of the rock at once picked out numerous specks of organic matter scattered through the crystalline matrix. During our recent visit the position of the dolomite within the Lower Gypsum Stage of the Series was confirmed. Specimens collected by ourselves are now being examined.

A piece of compact dolomitic limestone collected for us by Mr Lamba from a stratum exposed in the New Low Level Tunnel at Khewra, 1,335 ft from the entrance (Lamba No. 3, Khewra, July 1944), has yielded carbonized pitted tracheids and other woody tissues. We have, as before, been able to confirm the position of this stratum within the Saline Series.

A specimen of compact grey dolomitic limestone (coll. Sahni, Oct 5, 1944, W 15) from the main body of the Warchha valley Oil Shale group exposed in the section figured as an 'anticline' by Reed, Cottrell and Lahiri⁶ has revealed several woody fragments.

A finely laminated but compact grey dolomite, collected last year from the outcrop of the Oil Shale group near the confluence of the Jarhanwala an Jansukh streams (Sahni, Oct 13, 1943, S 21/1) was specially rich in angiosperm remains, for example a beautifully preserved grass cuticle, shreds of wood, several types of pollen and a stellate hair, besides organic membranes of unknown affinity. This dolomitic band is an integral part of the Oil Shale series with a dip and strike conformable with the rest of the strata in the group. Further specimens, taken last October, are being analysed for their fossil content.

Oil Shale From an outcrop near the same locality came a piece of dark grey Oil Shale (S 20), also collected in October 1943. It contained, among many other woody shreds, a gymnospermous tracheid with large elliptic bordered pits. This rock does not effervesce with hydrochloric acid, when heated it smells of petroleum and if kept longer in a flame it smokes, keeping alight even when removed. This articular bed could not be located last October, but other specimens of dark grey shales collected from within the Warchha valley Oil Shale series are being examined.

Some of the fossils here mentioned have been previously described and figured elsewhere^{7,8}. In a separate communication one of us hopes shortly to discuss the wider implications (practical as well as purely scientific) of the present work. Some of these problems, already suggested on independent grounds, have been set forth in important recent communications by Col Davies⁹, Dr A. Lahiri¹⁰, and Mr Lamba¹¹.

The simple approach which the microfossil technique offers to some of the intricate and long-standing problems of Salt Range geology lays bare in a striking manner its possibilities as an aid to stratigraphical work in general.

B SAHNI
B S TRIVEDI

Department of Botany and Geology,
University of Lucknow
Nov 6

¹ Sahni, B., *Nature*, 153, 462 (1944)

² Sahni, B., and Trivedi, B. S., *Nature*, 153, 54 (1944)

³ Lees, G. M., *Nature*, 153, 654 (1944)

⁴ Sahni, B., *Nature*, 153, 462 (1944)

⁵ Mani, M. S., *Ind. J. Entom.*, in the press, see (7)

⁶ Reed, Cotter and Lahiri, *Rec. Geol. Surv. Ind.*, (4), 72, 415, plate 11, fig. 1 (1930)

⁷ Sahni, B., *Proc. Nat. Acad. Sci. India*, 14 (1 and 2), 49 (1944)

⁸ Sahni, B., and Trivedi, B. S., *Proc. Nat. Acad. Sci. India*, 14 (1 and 2), "Palaeobotany in India", V, 86-87, plate 4, figs. 38-40 (1944)

⁹ Davies, L. M., *Nature*, 153, 53 (1944)

¹⁰ Lahiri, A., *Nature*, 153, 654 (1944)

¹¹ Lamba, B. S., *Current Science*, 258 (1944)

Chromatographic Separation of Coal Bitumens

INTEREST has long been focused on the so-called soluble coal bitumens, since Bone and Fischer demonstrated their influence on the coking characteristics of bituminous coals. Attention was specially directed towards the Fractions III and IV (Bone) of the high-pressure benzene extracts from coals. We need not recount the literature existing on the subject, but it is well known that there is no definite knowledge about the molecular nature of the coal bitumens except that they are complex mixtures. Recently, interest has been revived in the subject by Prof. I. L. Riley. From X-ray diffraction studies he suggests¹ that "the bitumen of the coal is responsible for the systematic variation in the *c* dimensions of the crystallites formed during carbonisation", and "It is therefore possible that the systematic variation of the *c* dimension is connected in some way with the coking phenomena." His researches have led him to investigate the carbonization characteristics of substances of known polycyclic structure. However, that may be, it is clear that investigations on the constituents of the coal bitumens themselves

would lead to a greater understanding of the subject if it were possible to isolate or at least resolve them into groups of substances of similar nature. Orthodox chemical methods have so far failed to resolve the components of coal bitumen. Although adsorption methods have been tried by some workers, it appears that no systematic application of the chromatographic technique (with all its vast elasticity) has yet been carried out. The only published example is recorded by Zechmeister and Frehden², who isolated a substance of the triterpene class from the light petroleum extract of a Hungarian lignite.

The chromatographic technique was tried and successfully applied by us in an effort to separate the high molecular weight oxidation products of oils. As many of the properties of these substances appeared to be similar to those of coal bitumens, samples of high-pressure benzene extracts of some coals were obtained from H. M. Fuel Research Station at Greenwich, and the fractions were subjected to chromatographic analyses. Results from preliminary experiments suggest that the problem of resolution of the bitumens into their components would yield to a systematic application of the ultra-chromatographic technique. The technique is simple and is as follows.

The sample (in this case Fraction IV of Mitchell Mam Dull—the part soluble in boiling benzene) is dissolved in the solvent and a chromatogram is developed on a column of suitable adsorbent, and the zones eluted by means of selective eluants. In the chromatography of bitumen, development of a liquid chromatogram is by far the most satisfactory technique, as several members of a homologous series may be present showing no interspace on the chromatogram. In the chromatography of Fraction IV, we used silica gel as the adsorbent. Sorbsil Gr. A (8-12 mesh) gel was crushed, treated with concentrated nitric acid for two hours on a steam bath, washed free from acid, graded by elutriation to 100-200 mesh size and cleaned with hot distilled water until completely acid-free. The gel was then dried at 110° C in shallow dishes and activated for two hours at 250° C before use. The adsorptive on the chromatogram has a uniform brown colour in ordinary light, and no recognition of zones is possible. Separation of the zones is, however, easily done by using ultra-violet radiation (364-400 Å), when distinctly different fluorescences of the adsorbate both on the column and in the eluate can be observed. Eluants of Analaar quality and 'chromatographically' purified are used for development and elution. The fluorescence in the eluate is best observed in very dilute solutions, as concentration tends to quench the fluorescence. For record purposes we take natural-colour photographs in ultra-violet light.

In the development of a liquid chromatogram, selection of the eluants is, of course, the most crucial point. In the chromatography of Fraction IV of Mitchell Mam Dull, for example, we have used the following solvents in the order stated: petroleum ether 60°-80° C (aromatic-free), petroleum ether plus 10 per cent benzene, benzene, benzene with 1 per cent ethyl alcohol, benzene with 5 per cent ethyl alcohol, benzene with 20 per cent methyl alcohol, chloroform, carbon disulphide saturated with methyl alcohol, and a 50:50 mixture of pyridine and carbon disulphide with 10 per cent methyl alcohol. In other cases, ethyl ether, carbon tetrachloride, cyclohexane and, for more strongly adsorbed substances, methylene chloride and tetrahydrofuran are good eluants. Of

other adsorbents (specially for rechromatography) activated alumina and magnesia are suitable media; Fullers earth (several types have been tried), flint, etc., are not suitable media, for besides effecting polymerization of the resinous substances, they adsorb coloured substances too strongly.

Fifteen different fractions were separated with the first seven eluants in the case of Fraction IV (part soluble in boiling benzene) two fractions, first, resinous substances with very strong bluish-yellow fluorescence, and second, a substance with strong powder-blue fluorescence with petroleum ether, and petroleum ether plus 10 per cent benzene, three fractions with benzene, having bluish, greenish and milky yellow fluorescence, six fractions with benzene plus 1 per cent ethyl alcohol, including three brown rings (non-fluorescent) at regular intervals, one fraction with benzene plus 5 per cent ethyl alcohol, one with benzene plus 20 per cent methyl alcohol, one with chloroform, one with carbon disulphide plus methyl alcohol. At the end of elution with these solvents, the chromatogram is completely stripped of adsorbate, except for a black ring on the top part of which can be dissolved in a mixture of pyridine and carbon disulphide. (The fluorescence colours noted are all ultra-violet fluorescence colours.) Each of these fractions can be further resolved into several fractions by rechromatography on aluminium oxide and magnesium oxide.

Applying similar technique, Fraction III of a Warwick Slate Bright coal sample has been separated into eleven fractions.

The behaviour of the fractions on the chromatogram indicates that the elution of the zones is a 'stripping' effect on the parts of a colloidal system, interspaces occurring between three groups which can be likened to the dispersing medium, protective colloids and micells of highly condensed carbonaceous substances. Interfacial tension is probably the main factor in the assembly, and therefore separation, of these substances.

Spectroscopic and other relevant data on the separated fractions are being collected and the complete analytical data will be published elsewhere in due course.

We wish to thank the Director of H.M. Fuel Research Station and Dr H. L. Horton for making the benzene pressure-extracts available to us and Prof W. F. K. Wynne-Jones for his helpful criticism and interest in the work.

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Nov 9

¹ *Proc. Roy. Inst. Chem.*, Pt IV, 127 (Aug 1944)

² *Nature*, 144, 331 (1939)

Denaturation and Renaturation of Proteins

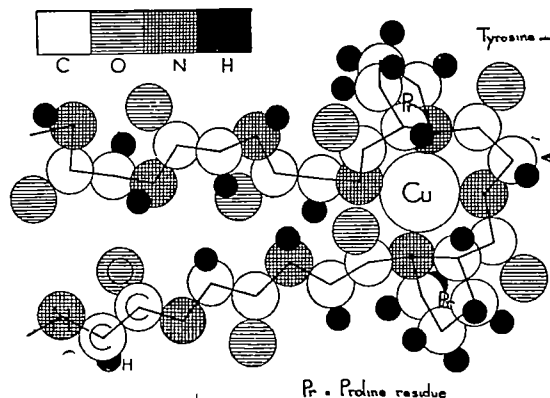
DESPITE the considerable advances that have been made in our knowledge of protein structure, the problem of denaturation remains somewhat obscure. A general theory of the phenomenon has been developed, which, although rough in its definition and speculative in character, is acceptable with varying degrees of qualification to most protein chemists. This theory supposes the uncoiling of a polypeptide chain (see, for example, Astbury and Lomax¹), but so far direct evidence in support of it has been meagre

and confused by experimental results that reflect chemical and physical reactions of secondary importance. These reactions may be avoided to a large extent by the examination of a protein of the greatest possible simplicity of structure. Silk fibroin, which is free from sulphur and contains a negligible number of amino- and carboxyl-groups, offers possibilities in this direction.

An earlier communication in *Nature*² indicated the possibility of renaturing silk fibroin, which normally occurs as a highly insoluble, fibrous protein. We have since found that the process of dissolution of fibroin in cupri-ethylenediamine, neutralization of the solution and dialysis, is attended, under suitable conditions, by complete renaturation of the protein. The optical activity, osmotic pressure, alkali-coagulating power, viscosity and tryptic digestion of the aqueous solution have been investigated, films of soluble fibroin have been prepared and examined by X-rays, and the analytical data for its constituent amino-acids have been extended. The results obtained lead to the following tentative conclusions.

The molecules of fibroin consist of long chains (length about 1300 Å, wt 33,000) orientated parallel to the fibre axis. In its natural state the chains are in the almost fully extended configuration corresponding to Astbury's β-keratin. They do not possess the regular periodicity of amino-acid distribution suggested by Bergmann and Niemann³, the greater part of the chain shows a regular periodicity but there appear to be two regions, relatively small and symmetrically placed in the chain, that are rich in tyrosine, and include all of the four proline residues (Abderhalden and Bahn⁴ isolated serylprolyltyrosine from fibroin). Adjacent chain molecules are linked by hydrogen bonds between opposing CO and NH groups of the peptide linkages.

On dissolution of fibroin in cupri-ethylenediamine, these bonds are broken and each of the Cu-en groups combines with two proximate NH groups along practically the whole length of the chain so that the whole molecule complex has a Cu: fibroin-N ratio of nearly 1:2 (the non-peptide-N in fibroin is very small). This complex formation occurs very rapidly and is followed by a slower reaction in which the chain folds back on itself at the two proline-containing centres to give a 3-limbed configuration (either as a lamina or prism of axial ratio approx. 20:1). The extent of the folding is dependent on time and concentration in the cupri-ethylenediamine. This folding is probably due to a swivelling of the molecular parts at a prolyl-tyrosylprolyl grouping in the two tyrosine-rich regions of the chain.



A possible structure of the hinge is shown in the accompanying diagram, in which there are four nating nitrogen atoms (all in one plane) for one copper atom, the co-ordination number of six for a Cu being completed by two water molecules in place of ethylenediamine, the four nitrogen atoms due to two proline, one tyrosine and one other amino-acid. The resemblance of this structure to myoglobin will be apparent. Neutralization of the α -ethylenediamine complex liberates the fibron in the completely renatured form (for which the name 'fibromogen' is suggested) or as a mixture renatured and denatured forms (both of molecular weight approximately 33,000) according to the conditions of dissolution. In the former case, dialysis yields a water-clear solution that gives no immediate precipitate on acidification and from which protein separates as a gel in the course of two or three days, the latter, the solution is more opaque and stable for periods up to fourteen days, and acidification to pH 3 causes immediate precipitation of the denatured fibron. It follows that the process of denaturation of fibron is essentially an unfolding of molecular chains, which, in appropriate circumstances, is followed by their subsequent aggregation.

One point of special interest in the above folded chain is that apparently the β -keratin configuration of the chain itself is retained. For example, careful evaporation of a layer of aqueous solution of renatured fibron leaves a water-soluble 'Cellophane'-like film that can be stretched when moistened to about three times its original length. The stretched film is completely insoluble in water and strongly refringent, and gives X-ray diagrams (β -keratin structure) identical with that of the unstretched film obtained from fibron powder. This is contrary to the theory of Bailey, Astbury and Rudall⁵ that denaturation (at least in a 'configurational' sense) is the conversion from the α - to the β -structure.

The degradation products of relatively high molecular weight, obtained by mild alkaline hydrolysis of fibron, are insoluble in water and dilute acids and alkalis, they may be 'regenerated', however, to give water-soluble products. Should this regeneration involve a folding mechanism, then it follows that these degradation products exhibit true denaturation. On the other hand, it is possible that regeneration here implies merely a separation of molecular aggregates. Fibron thus provides an example of reversible denaturation in which not only is complete renaturation unequivocally demonstrable for the first time, it also the freedom from ancillary changes gives a clear picture of a molecular change that may serve

as a basis for the general study of denaturation of fibron, denaturation consists simply of the unfolding of a molecular chain. The forces holding the folds in position are weak, and the unfolding readily occurs in aqueous solution. The straight chains thus formed are intrinsically soluble in water but, being no longer stabilized by intramolecular hydrogen bonds, they can only form hydrogen-bridges intermolecularly, that is, coagulation readily occurs. It is probable that this simple picture is not directly applicable to all proteins, the denaturation of most of which is attended by secondary reactions associated with thiol groups, extension of the molecular chain (β -keratin transformation), and other phenomena. The study of fibron has, however, provided an explanation that, while admittedly not entirely novel, is in accord with the general theory of the solubility of macro-molecules (see Lieser⁶) and removes much

of the vagueness that has been associated with a phenomenon of common occurrence and outstanding importance in protein chemistry.

A full account of this work will be published elsewhere in the near future.

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¹ *J. Chem. Soc.*, 846 (1935)

² *Nature*, **146**, 301 (1940)

³ *J. Biol. Chem.*, **122**, 577 (1938)

⁴ *Z. physiol. Chem.*, **210**, 246 (1932).

⁵ *Nature*, **151**, 176 (1943).

⁶ *Cellulosechemie*, **18**, 121 (1940).

Deaf-Mutism and Low Iodine Content of Water

THE association of congenital deafness or mutism with districts where endemic goitre and cretinism are prevalent is well known¹⁻⁵. It is now generally accepted that endemic goitre and cretinism occur among inhabitants of areas where the iodine content of the water is low, provided no other rich source of iodine such as sea fish is utilized⁶. 'Russell Brain' considered that many hereditary factors influence iodine utilization and that in congenital cases what is inherited is not goitre, cretinism or deaf-mutism as such, but rather some defect in iodine utilization. Hallpike⁸ has pointed out that congenital deafness does not necessarily involve a congenital anatomical defect, but may depend on an inherited predisposition to degeneration of certain tissues and be precipitated by biological factors, which are identifiable and subject to control.

A considerable amount of information has now been collected about the position of areas where the iodine content of the water is low, and the occurrence of endemic goitre in Great Britain⁹. During these clinical investigations on the distribution of thyroid enlargement, the highest incidence of deaf-mutism was found in districts where endemic goitre is prevalent and cretinism exists. In contrast with the incidence of goitre, men are affected with congenital deaf-mutism as often as women. In some cases deaf-mutes show enlargement of the thyroid gland, in others there is a history of goitre in some other member of the same family.

Stocks¹⁰, working on the records of the Board of Education Goitre Survey of 1924, found goitre markedly prevalent in north Oxfordshire, with a very high incidence for enlargement of the thyroid gland among children aged twelve in rural areas, for boys 11.39 per cent, for girls 37.22 per cent. He classed Berkshire as a non-goitrous county and recorded the low rates of enlargement of the thyroid gland among rural children aged twelve, for boys 0.83 per cent, for girls 3.88 per cent.

The Rev H. M. Ainger, working for the Association for the Deaf and Dumb of the Oxford Diocese, which also includes Berkshire, has made personal inquiries about the place of birth, age and residence of deaf-mutes in these districts. Using the records of the above Association, it is possible to compare the incidence of deaf-mutism in different areas and

correlate it with the iodine content of the water supply

In three districts of Oxfordshire, namely, Banbury Chipping Norton and Woodstock, which comprise one area, there is endemic goitre, the water supplies are low in iodine (1.4–3.0 µgm per litre), and the records showed 28 deaf-mutes in a total population of 36,653. In three districts of another area, Henley and Goring in Oxfordshire and Windsor in Berkshire, where endemic goitre is not prevalent and the iodine content of the water is moderate to high (10.1–52.2 µgm per litre), there were five cases of deaf-mutism in a population of 38,910.

We have records of endemic cretinism in certain Oxfordshire villages, in two instances two members of the same family. Goitre existed in other members of these families. Ten deaf-mutes from low-iodine areas in Oxfordshire were examined radiologically, four men and six women of ages between 16 and 61 years. These people showed bone changes in the skull, but of no consistent pattern. In some the deviation from the normal in the skeletal architecture was marked. The association of deaf-mutism with endemic goitre and cretinism in England supports clinical observations in other parts of the world.

It is suggested that a biological factor such as a low amount of available iodine, if associated with inherited defect in iodine utilization, may contribute to the incidence of congenital deafness. For such families the provision of an additional source of iodine, such as iodized salt, is indicated.

We are indebted to Miss B. W. Simpson, Rowett Institute, for estimation of the iodine content of drinking waters, and to Dr F. H. Kemp, Radcliffe Infirmary, Oxford, for radiological observations.

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¹ Bircher, H. (1883), quoted by Joll, C. A., "Diseases of the Thyroid Gland" (Heinemann, London, 1932).

² McCarrison, R., *Lancet*, ii, 1275 (1908).

³ Nager, F. R., quoted by Fischer, J., and Wolfson, L. E., "The Inner Ear" (Heinemann, London, 1943).

⁴ Stott, H., and Gupta, S. P., *Ind. J. Med. Res.*, 21, 655 (1934).

⁵ Census of India, 1931.

⁶ Young, M., Craibtree, M. G., and Mason, B. M., *Spec. Rep. Ser. Med. Res. Coun. London*, No. 217 (1936).

⁷ Brain, W. Russell, *Quart. J. Med.*, 20, 303 (1927).

⁸ Hallpike, C. S., *Brit. Med. Bull.*, 2, 119 (1944).

⁹ Goitre Subcommittee, Medical Research Council, *Lancet*, i, 107 (1944).

¹⁰ Stocks, P., *Quart. J. Med.*, 21, 223 (1928).

is derived from the limes (*Tilia Europea*) and the privet hedges (*Ligustrum vulgare*). Since the War, however, the prevalence of willow herb (*Epilobium angustifolium*) has served to modify the blend, producing ultimately a paler and sweeter honey. Some years there is also a substantial honey flow from horse-chestnut, sycamore and maple, but commonly in the year, these nectars are mainly consumed in brood-rearing and not stored.

My research into the flavours of honeys brought me into contact some ten years ago with Mr. E. K. Nelson, of the Bureau of Chemistry and Soils, Wood Research Division, Washington, who was able to establish the presence of methyl anthranilate in orange blossom honey and thus to identify a definite flavour. More recently, Mr. Pryce Jones and I have been investigating the peculiar bitterness of limonectar. The cat-like odour referred to by Dr. Melville, which is also associated with the flowers and leaves of *Ribes*, is, I think, unquestionably due to the privet, since it can be readily detected in country-gathered honeys when privet or wild privet prevail in the vicinity, but where *Ailanthus* is usually absent. Moreover, in Marketing Leaflet No. 31 (Ministry of Agriculture and Fisheries), "Honey-Grading and Marketing", privet is given specific prominence as an unpleasant natural taint to be guarded against. Incidentally, *Ailanthus glandulosa* smells of mice. I have had some experience with this tree as I grew quite a lot of it both outside and under glass at Purley Park, Berks. It is the natural food plant of the Chinese *Ailanthus* silkworm (*Philosamia cynthia*) which I reared in large numbers before my unsuccessful endeavour to acclimatize it in Battersea Park fifteen years ago. The larva does not smell, but the newly emerged moth smells strongly of mice. The *Ailanthus* by no means always flowers successfully, and according to Wedmore, even in California it is only considered of secondary importance for honey, and even that is of a poor flavour.

My present apiary, consisting of twelve stocks in the Gardens of the Zoological Society, Regent's Park, furnished me with a crop which, as a beekeeper, am quite sure was gathered from horse-chestnut, willow herb, privet and lime, and yet a pollen analysis by Mr. Yate Allen revealed the following bewildering variety:

Red or black currant (<i>Ribes rubra vel nigra</i>)	20
Lilies (Liliaceae)	15
Aubretia (<i>Aubretia</i>)	7
Laurel (<i>Prunus laurocerasus</i>)	7
Poppy (<i>Papaver</i>)	6
Hyacinth (<i>Hyacinthus</i>)	6
Tulip (<i>Tulipa</i>)	6
Asters (Compositae spp.)	6
Lime (<i>Tilia</i>)	5
Willowherb (<i>Epilobium</i>)	5
Hollyhock (Malvaceae)	5
Indeterminate—other flowers	12
	100

Sources of London Honey

As a perfumery research chemist and also as a London beekeeper for some eighteen years, I would like to point out critically but constructively that there is but little relationship between the several pollens found in a honey and the bulk of the nectars from which the honey is derived. I have samples of London honeys going back for about five years. These all exhibit the peculiarities mentioned by Dr. Melville in his communication¹. But as I have pointed out on several occasions in the lay press and elsewhere, from observation—and this will be endorsed by other London beekeepers—the bulk of the main honey flow from London (in particular the parks)

In a private communication received from Mr. Yate Allen in October, he says: "As I have pointed out on many occasions in lectures or writing, there are all sorts of pollen which get into the honey which have no relation to the nectar, such as the pollen from grass, poppies, plantain, etc., which produce no nectar at all. Then again, there are a lot of nectar-producing flowers which produce very little pollen while others produce it copiously. Limes, partly due to their pendulous position, produce very little pollen. Hence if bees also had access to some of the cruciferous flowers, one might find a sample of nearly pure lime honey to contain the largest percentage of grass, Plantago and crucifers."

Todd and Vansell² have shown by a series of experiments by collecting nectar from flowers with a pipette and also by analysis on the contents of the bee's honey stomach that not only do the number of pollen grains vary enormously with each species of plant, but also that they are in a large part removed while still in the honey sack of the bee by the action of the honey stopper into the ventriculus. The quantity removed depends on the length of time the bee spends on its gathering trip.

In conclusion, it may be said that whereas a pollen analysis of honey usually reveals its country of origin, only a chemical analysis can hope to reveal the sources of the nectars in its composition. I have this honey produced this summer in Hertfordshire showing a pollen count of 81 per cent *Castanea sativa* (sweet chestnut); if this should be of interest

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Nature, 154, 640 (1944)

J. Econ. Entom., 35, 728 (1942).

Honey from *Ailanthus*

THE attraction of hive-bees to the flowers of the Tree of Heaven, recorded by Dr R. Melville in *Nature* recently¹, has also been noted by me in Oxford. On July 14, 1944, I was awakened at dawn by a continuous high-pitched whining hum, like that of a dynamo, in the tall trees outside this Museum, and found it to be caused by thousands of *Apis mellifica* which were visiting the male flowers. The latter are obscure and small-petalled, in large panicles, and give off a strong musky scent. Dr Nicholas Poulton, who kindly identified the flowers as *Ailanthus altissima* (Mill.) Swingle, remarked that this kind of disagreeable smell is more commonly associated with fly-pollinated flowers such as certain Umbelliferae. But I searched several branches at different times of day, and found practically no winged insects on the flowers except hive-bees, apart from a few small adybird beetles.

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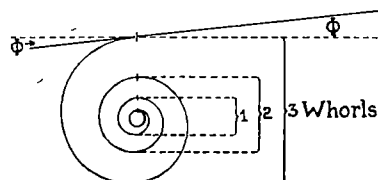
Nature, 154, 640 (1944)

Classification of Spiral Foraminifera

THE members of certain pairs of foraminiferal genera (*Nummulites* and *Operculinoides*, *Assilina* and *Operculina*, etc.) with flat spiral tests are distinguished from each other only by the rates (or angles) of opening of their spires. It therefore seems anomalous that no ruling exists as a guide in separating forms after this manner, for although the right allocation is often obvious, there are intermediate forms which might, at present, be as legitimately referred to one genus as to the other, in each of these pairs.

In order to suggest a criterion, I propose that a spire should be regarded as wide-angled if it doubles its diameter with each revolution. This criterion is easily applied when examining sections (whether equatorial or meridian), and represents a roughly intermediate degree between forms now separated by spiral

angles alone. If this criterion (or some other, for the one proposed has no inherent virtue beyond the convenience of the round figure 2) were generally adopted, it would secure more precision than now exists. I would also suggest, for this proposed critical rate of opening, the symbol $2d$, as signifying its doubling of the diameter with each revolution. An illustration of a uniform spire with this rate of opening is reproduced herewith.



All other rates could be similarly defined. Thus spires would have the symbols $1.7d$, $2.5d$ or $3.2d$ if, and so long as, their diameters increased by 70 per cent, 150 per cent or 220 per cent respectively, with each whorl.

Again, since foraminiferal spires are seldom constant for long, this convention would also enable one to define their variations, whether individual or ontogenetic. Thus one could say, of a certain species, that the rate of opening of its spire, at a given radius, varied from $1.5d$ to $1.8d$, and closed to about $1.4d$ at a later stated radius. It would thus be possible to give actual values to what at present can only be suggested in general terms—'very variable', 'becoming more crowded', etc.—besides enabling one to define the differences between spires better than has hitherto been possible.

I understand that, so long as a given rate of diameter increase is maintained, the outline of the whorls concerned may be represented by the equation $r = ce^{\alpha\theta}$, where r is the length of the radius vector, drawn from the centre of the spiral, c is the length of some initial radius also drawn from that centre, α is the index of the rate of opening, e is the base of Napierian logarithms, and θ is the angle made by the vector with the initial radius. The 'opening angle' (Φ in the diagram) is then $\tan^{-1}\alpha$, and either Φ or α may be taken as characteristic of the degree of openness of the spiral.

If the rate of increase is 2, then $\alpha = \log_e 2 / 2\pi = 0.1103$, and Φ is approximately 6.3° . Thus the critical rate of opening, for a wide-angled flat spiral whorl, could be taken as 6.3° , the practical test for that rate being the doubling of the diameter by the whorl.

L. M. DAVIES

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Noy 20

Specimens of *Asterias rubens* L. with Ten Tiedemann's Bodies

IT is well known that, in *Asterias rubens* L., nine Tiedemann's bodies are normally found. Elsewhere¹ I have previously recorded the occurrence of specimens with ten of these bodies, and have shown that the absence of the tenth (the presence of which makes the arrangement quite regular) cannot be accounted for by supposing that it is suppressed in order to 'make way for' the stone canal.

Since my previous note, the specimens of *Asterias rubens* used in the ordinary classwork of this Department have been carefully examined to see if further examples occurred and several have been found.

In my first note I recorded two out of twenty-five specimens which had this abnormality, and since then another eighty specimens have been examined of which four had ten Tiedemann's bodies. It would appear, therefore, that this condition may be expected in about 6 per cent of specimens, a slightly lower percentage than was previously suggested.

I should be glad to receive information as to whether this condition has been found by others. Negative reports would be as interesting as positive ones. The source of supply would also be a matter of interest.

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¹ *Ann. Mag. Nat. Hist.*, xi, 8, 61 (1941)

Observations on Bird Behaviour

WITH regard to the letters about birds pecking at windows and apparently attacking their own reflexions, it seems, judging from the reports of Dr Britton, Messrs Stephenson and Stewart, and Miss Frances Pitt, that this behaviour is considered to be confined mainly, if not entirely, to cock birds. At least, no mention is made in the correspondence of females behaving in this manner.

At present, there is a hen chaffinch in my garden that frequently pecks at the dining-room window. She has been doing this for five days now, and her pecking periods are astonishingly regular: 8.45–9.5 a.m., 11.30–11.50 a.m., 3.10–3.20 p.m., 3.45–4 p.m.; during these periods, but not of course continually during the period, she will peck at the window. At other times, even though she may be at the bird table near the window she ignores the glass. The dining-room is a long room with three big windows, each latticed. The same window and the same pane of glass is chosen each time. There can, in this case, be no question of territory defence.

The habit is widespread among birds. I have records of its occurrence in blackbirds, song-thrushes, missel-thrushes, house-sparrows, robins, chaffinches, greenfinches, pied wagtails, grey wagtails, blue-tits, great-tits, coal-tits, spotted flycatchers, starlings and jackdaws. Miss Pitt's record of a dipper is most interesting.

I can offer no explanation of the behaviour. I do not think that territory has anything to do with it—at least in the vast majority of cases. In one case, however, I think the tapping was intelligent behaviour designed to attract the attention of the humans in the room. During the very cold spell of early 1940, we would put food out on various tables round the house (I was then living near Winchester) and especially on a long plank running outside the billiard room. A great-tit frequented this 'table' and would drive all other birds, including a robin, away. If the plank was bare, he would stand and chirp and then fly at the window, striking it sharply, then back to chirp, then fly to strike, and so on. When food was put out he stopped. This particular bird was very tame—tamer than any of the others, most of which

would feed from the hand—and would fly to and sit on my shoulder, remaining there even if I walked indoors, but leaving if anyone approached.

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E. M. Stephenson and Chas. Stewart describe certain actions of a sparrow in what many students of animal behaviour would call somewhat anthropomorphic terms¹. They then remark that "It is usually stated that all bird behaviour is instinctive. Much of it can, of course, be adequately described by this term. It seems inadequate, however, to speak as though the whole of animal behaviour . . . can be classified under one of two terms—instinct or intelligence. Such stultified and obsolete terminology has long since been advanced upon by the psychologist dealing with human behaviour." But, by most modern animal psychologists such stultified and obsolete terminology is not employed. It seems, moreover, doubtful whether the study of animal behaviour would necessarily be advanced if, as suggested, investigators used "terms for all the grades of specific psychic phenomena", whether the word 'psychic' be used 'legitimately' or not.

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¹ *Nature*, 154, 801 (1944)

Open Packing of Spheres

SOME automatic and continuous coal-weighing apparatus make use of the experimental fact that graded-to-size coal weighs the same per unit volume whatever the size of the lumps, hence a cubic foot of large lump coal weighs the same as a cubic foot of small lump coal.

This is easily proved. Let n be the number of spheres in one foot length, then if there are n^2 spheres in each layer, the total number of spheres in 1 cub. ft. is n^3 and the radius of each sphere is $\frac{1}{2n}$ ft.

and its volume is $\frac{4}{3}\pi\left(\frac{1}{2n}\right)^3 = \frac{\pi}{6n^3}$ cub. ft., and as there are n^3 spheres, the total volume of the spheres in 1 cub. ft. is $\frac{\pi}{6} = 0.524$; that is, a little more than half is coal, and less than half is voids. As neither n nor r occurs in the expression for the volume, the number and size of the spheres do not affect the weight per cubic foot. This holds good only for the packing implied. If the closest packing is adopted, then the percentage of solids (density) increases as the size of the spheres decreases.

If the packing is such that one sphere touches eight others, then it can be shown that for spheres 1 in. in diameter, the total number in a 10-in. cube is 1,205, and the ratio of the volume of the spheres to a 10-in. cube is 0.631, while if the spheres are 2 in. in diameter, the total number is 132 and the density is 0.553 and if there are 40 spheres in the 10-in. edge, the total number of spheres is 87,388 and the density is 0.715.

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RESEARCH ITEMS

Preparation of Epidemic Typhus Vaccine

A. P. BERKOWITZ (*S Afric J Med Sci*, 9, 109, 1944) has investigated the suitability of duck and chicken eggs for the large-scale preparation of epidemic typhus vaccine. Duck embryos live longer (8–9 days) after inoculation than chick embryos do (6–7 days). The growth of rickettsiae in the yolk sac of the duck egg is far more prolific than in the yolk sac of the hen's egg, and the duck egg's yolk sac at the stage reached (15–16 days old) is about twice as big as that of a 13–14 day hen's egg. Duck eggs inoculated by his method gave, on the 7–8th day after inoculation, a South African strain of epidemic typhus, an average yield of 100–200 c.c. of vaccine, which is about five times the yield of hen's eggs. Stained sections show, in a high percentage of yolk sacs, an almost confluent sheet of rickettsiae, "quite beyond anything seen even in the most heavily infected hen's eggs". Because the yield per yolk sac is so high, the actual proteins are correspondingly diluted, so that processing is easier. Preliminary protection tests ininea pigs have indicated that the protective value of the duck egg vaccine is at least equal to that of a hen egg vaccine. A Middle East strain of epidemic typhus gave a similar extremely prolific growth in duck eggs. In turkey eggs the growth is just as prolific, and the yield of vaccine as great. It was found that the best conditions for many incubation of duck eggs were a temperature 102°F in a completely humid atmosphere.

Biology of a Hymenopterous Parasite

THE *Journal of Agricultural Research* (69, Aug. 15, 1944) contains a paper by D. W. Clancy of the U.S. Department of Entomology and Plant Quarantine dealing with the parasite *Allotropa burrelli* Mues. This insect is a member of the family Platygasteridae and parasitizes the mealy bug known as *Pseudococcus asstocki* (Kun.), which has recently become a serious pest of apple in parts of Virginia, West Virginia and so on. The parasite was introduced into the United States from Japan in 1939 with the object of aiding the control of the pest already mentioned. It appears that the development of the parasite in the host is usually monoembryonic, although twinning may occasionally occur. There is only a single larval instar and the larva bears but one pair of spiracles which is situated on the first segment. Three twin embryos were found out of the hundreds that were examined. Two of these were early morulae each with a separate chorionotic layer, tightly enclosed in a membrane probably derived from the surrounding tissues of the host. The third pair was more advanced, and since the embryos were enclosed in a single trophamnion, it seems no doubt in this case that they were derived from a single egg. It appears, therefore, that a very simple type of polyembryony may occur under rare circumstances. The details of the process are very much the same as have been described by Day and Hill in *Platygaster hemelis*.

Characin Fishes from Venezuela

LEONARD P. SCHULTZ has recently reviewed the fishes of Venezuela. The present report is a continuation of this work, being the second contribution to the fishes of Venezuela resulting from the author's expedition to that country to study the fish fauna, especially of the Maracaibo Basin, during February–May

1942 ("The Fishes of the Family Characinae from Venezuela with Descriptions of Seventeen New Forms", *Proc. U.S. Nat. Mus.*, 95, No. 3181, Washington, 1944). The previous report (*ibid.*, 94, No. 3172, 1944) gives details of stations, etc., where specimens were collected. This family consists of freshwater fishes found in both Africa and South America, and is most closely related to the Nemato-gnathi or catfishes and to the Cyprinidae. An artificial key is given to the many genera and also in most cases keys to the species. Recently, George Sprague Myers has described a new genus and species of Characoid fishes from the Rio Negro, Brazil, for which he proposes the name *Rhinobracyon negrensis* (*Proc. Calif. Acad. Sci.*, iv, 23, No. 39, 1944). Thus he regards it as a close relative of *Bryconamericus*, the generic characters, however, being well defined.

Vegetation of the South Brazilian Plains

An interesting paper, "Profundidade dos solos e vegetação em campos cerrados do Brasil meridional", by Felix Rawitscher, Mario G. Ferri and Mercedes Rachid (*An. Acad. Bras. Cienc.*, 15, 1943), is a continuation of studies published in the same journal in 1942. An examination of the water balance of *campos cerrados* (the fields in Emas, near Pirassununga, present the typical vegetation of the *cerrados*) led to the following conclusions: (1) The water content of the soil is high, as a number of tables show, and the underground water-level occurs at a depth of 17–18 metres. (2) The vegetation consists of plants which grow only during the rainy season, and Gramineae with superficial roots which wither when there is a lack of water. There were also shrubs and smaller trees with very deep roots, many of which remain green during the whole dry period. (3) A number of experiments in rapid weighing, infiltrations, etc., showed that the stomata were open during the whole day and that the saturation deficit of the leaves was always small. The behaviour of the plants was not that of xerophytic vegetation, a fact in accordance with the great water reserves available to the plants. (4) The daily values of transpiration and evaporation are smaller than has been generally supposed, and the "campos cerrados" of the type studied do not present arid conditions, as is usually implied when they are included among the savannas. The arid appearance is due to annual fires, and the effects of dryness are limited to the surface only.

Diazocyanides

As is well known, Hantzsch regarded the isomeric diazohydroxides, sulphonates, and cyanides as *syn*- and *anti*-geometrical isomers. H. H. Hodgson and E. Marsden (*J. Chem. Soc.*, 470, 1943) showed that the so-called *syn*- and *anti*-diazosulphonates are not geometrical but structural isomers, namely, diazosulphites and diazosulphonates, respectively. The same authors (*J. Chem. Soc.*, 395, 1944) have now presented evidence indicating that the aryl so-called *syn*- and *anti*-diazocyanides are also structural isomers, namely, isonitrile and nitrile structures, containing N–N and N–C bonds in the molecule. The conversion of the non-coupling *p*-nitrobenzene-diazocarbonamide with a stable C–N bond, by reaction with bromine, into an N-bromocarbonamide, which will then couple with α - or β -naphthylamine in non-aqueous media, as also with β -naphthol in aqueous alcoholic and alkaline solution, indicates that Hofmann reaction has occurred, and that the intermediate

diazotate with its easily ruptured N—N bond will couple. Other lines of evidence in support of their view are given by the authors. Hantzsch's formulation of the aryl *syn*-diazocyanides as $\text{NR}=\text{N}-\text{C}\equiv\text{N}$ is regarded as correct, but the supposed *anti*-form is

the *isocyanide* $\text{NR}=\text{N}-\overset{+}{\text{N}}\equiv\text{C}^-$, the two thus containing central N—C and N—N links, respectively, as stated above. The correctness of Hantzsch's formulation has, of course, been questioned many times before, but the new evidence is interesting.

Stability of Ascorbic Acid

AN investigation of the effect of conditions of storage on the stability of ascorbic acid in various foods, etc., carried out by J. B. Marshall, J. W. Hopkins and G. A. Young (*Canad. J. Res.*, 22, 39, 1944), showed that jams to which ascorbic acid had been added after processing, and a natural orange concentrate, retained 70–80 per cent of the ascorbic acid on storage for periods up to a year when protected from moist conditions. 'Fortified' jams retained 75 per cent after six months at 23.9°C. When exposed to conditions of high relative humidity and temperature the products became objectionable from the point of view of physical appearance before the ascorbic acid losses became excessive.

Impedance Measurement at High Radio Frequencies

At a meeting of the Radio Section of the Institution of Electrical Engineers on December 6, L. Essen read a paper describing methods and apparatus, developed in the Radio Department of the National Physical Laboratory, for the measurement of both balanced and unbalanced impedances at frequencies between 375 and 750 mc/s. The equipment consists of an air-spaced concentric line for unbalanced impedances and a screened twin line for balanced impedances. The method is based on the principle described by R. A. Chipman in 1939, and consists in varying the length of line by means of a movable bridge carrying a thermojunction unit to determine the positions of current resonance. The component to be measured is connected to the open end of the line, and the impedance is evaluated from the readings of resonant length and the width of the resonance curve. Convenient working equations are developed by Dr. Essen, who also describes the results of a number of measurements made to check the validity of the assumptions involved. The main application of the apparatus has so far been to the determination of the propagation constants of radio-frequency cables, these constants being deduced from the values of the input impedance of a length of the cable under different conditions. By a suitable choice of the conditions of measurement, the effect on the input impedance of the discontinuity at the junction of the measuring line and the cable can be measured and practically eliminated. From the considerable experience obtained in the use of these methods during the past three years, the accuracies achieved for a wide range of reactance and resistance values are found to be ± 2 per cent and ± 5 per cent respectively.

Long Duration of the Balmer Spectrum in Excited Hydrogen

CURRENT theories and experimental determinations of the time of relaxation of the hydrogen atom lead one to expect that in about 10^{-8} sec the intensity of light of a condenser discharge through hydrogen

emitting the Balmer series of lines would diminish in the ratio e^{-1} . Lord Rayleigh (*Proc. Roy. Soc. A*, 183, 26, 1944) reports experimental determinations in which hydrogen, made luminous by a powerful discharge, is blown out of the electric field by thermal expansion. In some experiments the time in question is one thousand times greater than the expected value. As the discrepancy is not cleared up, the results are reported in sufficient detail for critical examination.

Molecular Structure of Dielectrics

In a paper entitled "An Elementary Description of Some Molecular Concepts of the Structure of Dielectrics" (*J. Inst. Elec. Eng.*, 91, Part 1, No. 48 Dec. 1944), E. B. Moullin gives an account of some of the atomic and molecular concepts necessary for the formation of a model that will give a rational description of certain behaviour of dielectrics. The dielectric constant of many materials is found to depend on the radius of the molecule, and the phenomenon of permittivity can be included in the inverse-square law of force between charges if the molecules can be supposed to exhibit an effect equivalent to that of electrostatic induction. Dr. Moullin gives an outline of the Bohr atom and the electron theory of valency, and this provides a mechanism equivalent to induction as well as one whereby it is expected that certain molecules possess a permanent electric moment, which molecules are shown by direct experiment to be electric dipoles. A graph of description is given of the manner in which dipoles must produce heat when the dielectric is in an alternating electric field. The paper closes with a brief description of certain experiments which have been designed and made to show that molecular dipoles are a cause of dielectric losses, and a brief discussion of whether they are the main cause of the losses experienced in the insulating materials commonly used in electrotechnology.

Division Errors of a Reversible Transit Circle

Sir Harold Spencer Jones, the Astronomer Royal, and R. T. Cullen have determined the division errors of the fixed circle of the reversible transit circle at the Royal Observatory, Greenwich (*Mon. Not. R. Astr. Soc.*, 104, 4, 1944). The fixed circle was divided on an automatic dividing machine, as usual with large circles, but by a new "method of division by generation" which was devised by Messrs. Cooke, Troughton and Simms, Ltd., and this method was expected to give smaller division errors. In the case of circles divided on automatic dividing machines it has generally been assumed that division errors could be represented as a sum of periodic terms, but as such an assumption would not necessarily be valid for the new method, a programme was arranged to determine the error of each division without any assumptions. A full description of the method, which occupies eighteen pages, is given. It was found that the analysis of the division errors showed a cyclical but irregular variation of $2\frac{1}{2}^\circ$ period and that the form depended on the position in the circle. The 0° – 90° section resembles the 90° – 120° section, as the 30° – 60° resembles the 60° – 90° . When the 2° variation was removed, periodicities of 15° , 30° and 60° appeared, and it is possible that the remaining fluctuations were due to accidental errors of detection or of dividing. The error of each of the 5' graduation marks over an arc of 120° was determined with probable error of $\pm 0.028''$.

ELECTROCHEMICAL PROPERTIES OF SILICIC ACID SOLS

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AND

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THE properties of silicic acid sols have been studied by several investigators¹⁻¹⁰. Differences of opinion^{1,2,3} have been expressed as to whether sols possess any intrinsic acid character. In a number of publications from this laboratory the fractions of silicic acid sols with bases^{11,12,13,14}, neutral salts^{15,16} and acids^{17,18} have been discussed. These sols even after purification by prolonged electrolysis have free acidities of the order of $10^{-4} N$. Their ultra-filtrates have a practically neutral reaction, showing that mobile H^+ ions associated with the

continued buffer action beyond the first inflexion point takes place, and a second inflexion (Fig. 2) between pH 11.0 and 11.7 corresponding to the formation of $NaHSiO_3$ is observed¹³. An inflexion at pH 11.8 in the titration curves of silicic acid sol with concentrated alkali has been observed by Treadwell and König⁴. The plot of the buffer capacity

$\beta \left(= \frac{\Delta B}{\Delta pH} \right)$ against the concentration of the alkali shows a maximum near the point of half neutralization, indicating that up to the second inflexion only the first stage of neutralization of H_2SiO_3 is reached. The maximum value of the buffer capacity does not occur exactly at the point of half neutralization.

The sol behaves as a strong acid as judged from (a) the form of the titration curves with small additions of very dilute bases, and (b) by the manner of variations¹⁴ with dilution and temperature of the free acid and the total acid at the first inflexion point. The free and total acids decrease almost linearly with

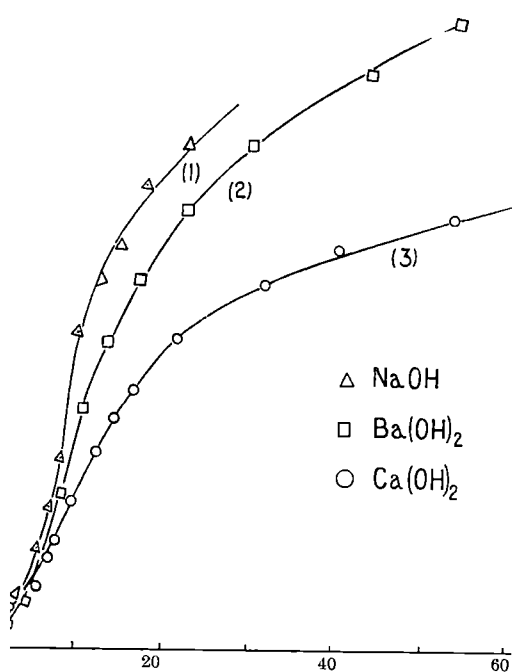
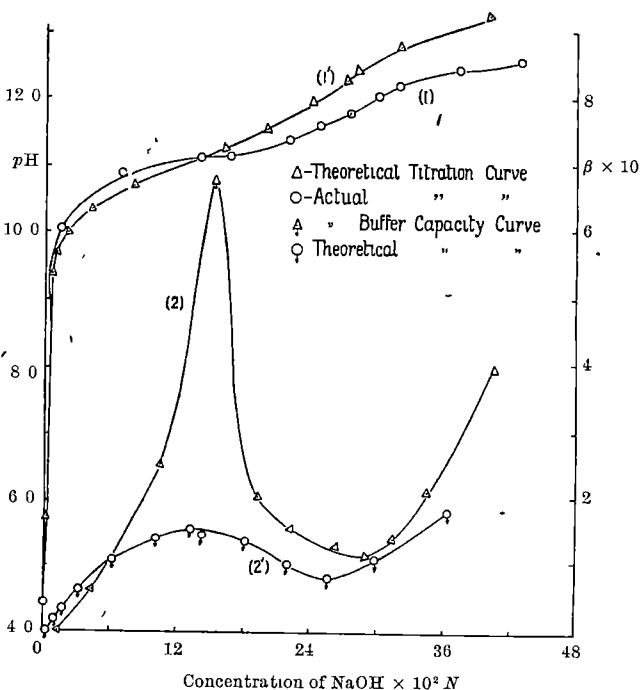


Fig. 1. SILICIC ACID SOL M

colloidal particles give rise to the observed free acidity of the sol.

The titration curves (Fig. 1) of the sols with dilute bases show an inflexion (first inflexion) in the acid region^{12,13} at pH 4.5-5.5. This inflexion cannot be referred to the neutralization of any dissolved acid present in the sol, as the ultrafiltrate has negligible free and total acidities. The total acid neutralized by several dilute bases at this inflexion point is a constant quantity. The slopes of the titration curves, however, indicate the order $Ca(OH)_2 > Ba(OH)_2 > NaOH$. The intensity of reaction of the various bases with the sol. The 'irregular or specific' cation effect observed with hydrogen clays^{12,20} is indicated by order.

With increasing concentrations of caustic soda a

Fig. 2. SILICIC ACID SOL L'. THE THEORETICAL CURVES REFER TO THOSE OF A HYPOTHETICAL ACID HAVING THE SAME TOTAL ACTIVITY (OR SECOND INFLEXION) AND pK AS THE SOL.

dilution (from 0.3 gm. per litre to 0.04 gm. per litre) and do not materially change with temperature within the range $1^\circ-50^\circ C$. A weak acid character of the sol is indicated (a) by the buffering in the range pH 6-8 beyond the first inflexion, (b) by the comparatively low ratio (0.5-0.8) of the free acid to total acid at the first inflexion, which is of the order of $10^{-4} N$, and (c) by the manner of the variation of the pH of the sol on the addition of acids. A smaller lowering in the pH is observed¹⁸ on the addition of a given concentration of an acid to the sol than when added to hydrochloric acid of nearly the same pH as the sol.

The dissociation constant calculated from different points of the titration curve with a dilute base on the basis of the total acidity at the first inflexion

point has different values¹³. The pK values calculated from the pH at the point of half neutralization in the titration curves with concentrated alkalis decrease with a decrease in the silica content of the sol. The dissociation constant calculated from the pH at the second inflexion and from a consideration of the solubility of silicic acid varies from 4.4×10^{-10} to 5.9×10^{-10} with different sols and is found within the range (10^{-9} – 10^{-10}) observed by previous workers^{5,6,7,8}.

The amounts of acid liberated from the sol by neutral salts as shown by the diminution in its pH ^{15,16} on the addition of salts and by the total amount of acid¹⁰ found in the salt extracts are in the order $Ba^{++} > Ca^{++} > K^{+} > Na^{+} > Li^{+}$, which follows the lyotrope series and illustrates what has been designated^{12,20} as the 'regular cation effect'. The greater relative effect of Ba^{++} ions compared with Ca^{++} ions is definitely against the explanation that the development of acidity is due to the formation of insoluble silicates^{9,10}, since calcium silicate is more insoluble than barium silicate. The order, on the other hand, follows from an electrical adsorption of the cations together with their hydration envelopes.

The amount of acid liberated by continually leaching the sol with a definite concentration of a neutral salt diminishes¹⁶ to an almost negligible value as the leaching progresses. The total amount of acid thus liberated, especially by barium and calcium chlorides, is considerably greater than that neutralized at the first inflexion point in the titration curve with a dilute base. This indicates that 'bound' H^{+} ions¹⁰ are present in addition to those which can react with the base at the first inflexion point. The total quantity of the so-called salt that is formed by continued leaching of the sol with a solution of neutral salt is a small fraction (0.13 per cent) of the number of moles of silicon dioxide present (cf. also Moltschanowa¹⁰), indicating that the reaction with the salt is limited to the surface and does not appear to lead to the formation of a second solid phase.

At very low concentrations the alkali metal cations cannot easily displace the 'bound' H^{+} ions associated with the colloidal particles, but only effect an osmotic displacement of the mobile H^{+} ions¹⁶. With lithium chloride the displacement of mobile H^{+} ions is complete at a concentration of 0.01 N .

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³ Rabinowitsch and Kargin, *Trans. Farad. Soc.*, **31**, 289 (1935).

⁴ Treadwell and König, *Helv. Chim. Acta*, **16**, 468 (1933).

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⁶ Harman, *J. Phys. Chem.*, **31**, 616 (1927).

⁷ Joseph and Oaklev, *J. Chem. Soc.*, **127**, 2913 (1925).

⁸ Treadwell and Wieland, *Helv. Chim. Acta*, **13**, 842 (1930).

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¹² Mukherjee, Mitra and Mukherjee, S., *Trans. Nat. Inst. Sci. India*, **1**, 227 (1937).

¹³ Chatterjee, *J. Ind. Chem. Soc.*, **16**, 589 (1939).

¹⁴ Chatterjee and Sen, *J. Ind. Chem. Soc.*, **19**, 17 (1942).

¹⁵ Mukherjee, Ghosh, Krishnamurti, Ghosh, Mitra and Ray, *J. Chem. Soc.*, 3023 (1926).

¹⁶ Chatterjee, *J. Ind. Chem. Soc.*, **16**, 607 (1939).

¹⁷ Mukherjee, *Nature*, **115**, 497 (1925).

¹⁸ Chatterjee, *Proc. Ind. Sci. Cong. Assoc.*, **3**, 73 (1942).

¹⁹ Mukherjee, *Phil. Mag.*, **44**, 321 (1922), *Trans. Farad. Soc.*, **18**, 103 (1921).

²⁰ Mukherjee, Mitra, Chatterjee and Mukherjee, S., *Ind. J. Agric. Sci.*, **12**, 86 (1942).

SCIENCE IN THE MODERN STATE

MR H. S. MORRISON'S L. T. Hobhouse Memorial Trust Lecture, which was read on his behalf by the Provost of University College London, at Cambridge on May 9, 1944, has now been published under the title "Science and Administration in Modern Government" (London: Oxford University Press, Pp. 202s net). The lecture concerned mainly with the part which science can and must play in our affairs after the War if we are to survive and progress as a community, and more especially with social research or social engineering. Mr Morrison emphasized first the speed of scientific development at the present time and the scale upon which much of it proceeds. War-time experience seems to have established that there is no reason in the nature of things why Britain, admittedly a leader in fundamental research, should be any less good in the sphere of development and application; secondly, progress in the theoretical and practical solution of specific problems can be incredibly quick when 'all the brakes are off', and the object is not to serve the *status quo*, but to surpass it as rapidly and as far as possible; and thirdly, that science as a method can be applied to almost any problem, however unlikely, and almost any material, however apparently intractable.

With regard to the first point, Mr Morrison urged that we must reduce the risk of important and fundamental British inventions being developed abroad and then brought back in the form of finished and patented processes upon which the British manufacturer must pay a substantial royalty if he wishes to use them. The second lesson, the possibility of accelerating the rate of progress by removing obstacles, takes us deep into questions of economic and industrial policy, and Mr Morrison pointed out that every large change in the social and economic sphere has its costs as well as its advantages, the calculation which has to be made will not necessarily show a result favourable to immediate change. It should, however, be our practice as a community to write off our existing capital assets at a good rate, but it should not, he urged, be left to the unaided devices of large firms to calculate whether certain change is justifiable or not. The calculation 'to scrap or not to scrap' may yield one answer: the company accountant and another answer to the Chancellor of the Exchequer. We ought to bear in mind, in considering the appropriate form of relationship between the State and industry after the War, the importance of ensuring that public policy effectively operative when great and vital decisions affecting our industrial progress are being taken.

After referring here to the possibilities of scientific development of the supplies of coal, oil and sugar within the British Commonwealth, and to the possibilities of biological development as indicated by penicillin, biological control of plant, insect and animal life, including the biological use of X-rays, Mr Morrison illustrated the third lesson from the work of the Research and Experiments Department of the Ministry of Home Security in the application of scientific methods to problems of civil defence, such as the evaluation and development of types of shelter. Such methods have obvious application in building and one of the first-fruits of such operational research has been the preparation of more than a score of monographs on the technique of building structures. Lord Portal's temporary post-war dwelling-house

further example of the practical application of research techniques and a precursor of greater things come

Such social research is part of a distinctive tradition British social science, and Mr Morrison expects great extension of the techniques of exact quantitative study on society, social groups and their environment on one hand, and on the other the extension of social research into the qualitative field. In regard to the first, Mr Morrison urged the importance of study of social mobility—the rate and machinery of transfer from one social class or group in one society to another. He suggested that a study in Great Britain might show the universities acting to some extent as engines of social mobility, and to a greater extent as instruments of individual economic advancement. Again, the problem of marriage and the question of actual geographic mobility requires investigation. In spite of their increasing importance, the age structure, we know little about the old as a social factor beyond their numbers. We know little about the factors that shape the choice of occupation on leaving school, and how far this is affected by the occupation of their parents. Besides this quantitative approach, we need as supplement the development of the case-history method—an intensive study of a number of individuals either by specially worked out methods of question and answer or by methods of word-association and picture-association. The development of personality and mobility tests in the Services is a small beginning of this kind of approach, but the programme of extended social research would call for the creation of a new generation of social workers, and the training of large groups of students. Mr Morrison is looking with keen anticipation to the extension in the social field of scientific techniques. Social scientists have a tremendous contribution to make to intelligent enlightened government, and Mr Morrison believes that the full fruition of the social sciences, at present at a stage corresponding to the early phases of the physical sciences when they were uncertain about their explanations of cause, may not lie so far ahead of us.

PETROLEUM IN WAR AND PEACE

THE American Office of War Information has recently received a publication entitled "Developments and Trends in American Industries (Oil Refining and Refining, High Octane Gasoline)" which is in fact a collation of excerpts from trade magazine articles and other sources. It covers practically every activity of the American petroleum industry to-day, and gives some striking pointers as to the way in which war-time scientific discoveries will be harnessed to meet peace-time requirements.

Driven by the necessity for producing high-quality aviation fuels in enormous quantities, research workers, sponsored by the Petroleum Industry for War Council and the Aviation Gasoline Advisory Committee, have made startling progress. Until recently, 100-octane gasoline was regarded as an optimum fuel, but it has been superseded as a standard. There is a new 'Supergas' called triptane (paraffinic-trimethyl-butane), which is 50 per cent superior to 100-octane from which 100-octane gas is obtained, its anti-knock qualities are such that no commercial engine has been built which is capable of utilizing its full power. There is 'Dynafuel', which

is also 50 per cent more powerful than standard 100-octane fuel, and there are no doubt other fuels of similar calibre which will become commercially available in peace-time. One is tempted to forget that the use of 100-octane spirit or super-gasoline for post-war motoring purposes implies the evolution of a 'super-car'. It is, in fact, unlikely that such fuels will be used in motor-cars for some long time to come, but it is interesting to note that petroleum chemists do envisage the production of a 70-mile-to-the-gallon motor spirit, not to mention 100,000-mile tyres, and 20,000-mile lubricating oils.

Second only to aviation gasoline in war-time importance is the production of toluene for T.N.T. (trinitrotoluene). During the War of 1914-18, practically all the toluene used was produced from coal tar, but to-day, although more toluene is being manufactured in that way than ever before, the greater part is being supplied from petroleum oil refineries. Indeed, the capacity of hydroformer installations and attendant toluene extraction and purification plants has been so increased that it has been found possible to divert some of the toluene to 100-octane activities, after fulfilment of all requirements for explosives. Toluene in peace-time is a commercial solvent used in dyes and paint manufacture, but quantities required are not in any way proportionate to war-time demands. Petroleum chemists foresee a sharp decline in toluene production after the War, but they equally foresee the possibility of converting toluene-manufacturing plants into machinery for making gasoline-blending agents.

Other war-time activities of the petroleum industry include the supply of a large part of the butadiene for the production of Buna-S type synthetic rubber, production of high-quality lubricating oils, hydraulic oils, and special types of lubricants capable of withstanding the bitter winter conditions of Greenland or alternatively the heat of the Sahara desert. Waxes more moisture-proof than tin, rust preventives, de-icing materials, fireproofing compositions for soldiers' tents, preservatives for mosquito nets, medicines, anaesthetics and a host of other war-time commodities are prepared from petroleum derivatives. In fact, refining has become so highly skilled compared with the old days when cuts were made to satisfy demand for one product only that its repercussions on post-war industry will be nothing short of revolutionary. To-day the petroleum chemist is master of a formidable number of highly specialized processes, for example, hydrogenation, dehydrogenation, hydroforming, reforming, alkylation, polymerization, isomerization, catalytic cracking, aromatization, cyclization, etc., and he literally tears apart (cracks) the petroleum molecule and reassembles it into the pattern he desires.

But it is not only the petroleum chemist who has forged ahead. Other branches of the industry have made parallel advances. In 1922 the deepest producing well in the world was in the Orange Field, Texas, it reached a depth of 5,490 ft. To-day a well in the Terrebonne Parish Field of Louisiana has been drilled to, and is producing at, a depth of 13,475-90 ft. A new era in the art of exploration and discovery began with the use of the torsion balance and the seismograph. To-day gravimetric methods, electrical measurements, aerial mapping, geochemical and radiation techniques are all available to assist in the search for oil. Before the entry of the United States into the War, practically all the petroleum and petroleum products consumed in the

Atlantic Coast States were transported there by tanker. Now the "Big Inch" pipe-line is delivering more than 300,000 barrels of crude oil daily to refineries on the Atlantic seaboard, while the "Little Big Inch" delivers domestic fuel oil to the New York Harbour area. The "Big-Inch" main line is 1,254 miles long and the "Little Big-Inch" 1,475 miles.

SOUTH AFRICAN INSTITUTE FOR MEDICAL RESEARCH

THE annual report for 1943 of the South African Institute for Medical Research, Johannesburg, is a record of valuable war and other work. The work of the South African Medical Corps Establishment is directed from the Institute and is organized into eight sections. Their work includes the supply and administration of the seven large and fifteen small laboratories situated at military hospitals all over the Union and the two mobile laboratories based on the Institute, training of personnel in tropical medicine and laboratory work, which has been extended to naval medical officers, a military blood transfusion service, which has developed considerably, the supply of glucose saline and other fluids for intravenous use, a snake-catching unit, which caught an average of 50-75 cobras and puff-adders a month to provide venom for the manufacture of antivenene by the Institute (a larger and more permanent snake farm at Barberton is being planned and a valuable agreement has been made with the director of the Pasteur Institute Brazzaville, French Equatorial Africa, for the supply of venoms from equatorial snakes), and a unit for catching gerbils for the use of the typhus-vaccine department, which catches about 1,000 gerbils a month. Assays of vitaminized foodstuffs have been done by the biochemical department for the Director of Supplies, the Red Cross Prisoner-of-War Parcels Section, and other authorities. The Institute is at present the only laboratory in South Africa able to undertake the assay of vitamins in foods. An important part of the war effort has been the continued production of typhus and yellow fever vaccines and other curative and protective sera for military use, and also the building up of a reserve of anti-gas-gangrene serum.

Research work has been done on pneumonia, meningitis, diphtheria, tuberculosis endotoxin, vaccine, tetanus, whooping cough, dysentery, plague, syphilis and other diseases. The enzyme purification and concentration of tetanus and diphtheria antitoxin, anti-gas-gangrene serum and polyvalent antivenene has made such progress that it is possible to plan large-scale manufacture of various antitoxins by this process. The susceptibility of various South African rodents to vole acid-fast mycobacterium of tuberculosis has been studied. Gerbils dying after a dose of 0.0001 mgm. had lesions with a histological appearance between those of tuberculosis and leprosy. Much work has been done on anti-typhus vaccines. It is claimed that experiments with the intradermal injection of typhoid vaccine have given satisfactory results, with this method less vaccine is required and there are no local or general reactions.

Considerable research work has been done on gas gangrene, one interesting result of which has been that, among eleven samples of sera of wild animals

examined, the sera of two zebras, one myala, f impala and four kudu contained *Cl welchii* antitoxin.

It has been shown for the first time that epidemic typhus in the Transkei Territory is transmitted by lice. Murine typhus and tick-bite fever also occur in this territory. By serological tests, using paratyphoid suspensions, it has been found possible to differentiate between epidemic typhus, murine typhus and tickbite fever.

Entomological work has included a study of distribution of sandflies, species which transmit kala-azar have been found in Southern Rhodesia. This discovery is important because troops return from areas in which kala-azar is endemic may bring home this disease. A survey of the fleas of the South African Union is also being made. Other subjects of study have been rat-mite dermatitis, due to *Liponyssus bacoti*, which is very common on rats in Johannesburg, intestinal myiasis due to Diptera larvae, the toxin found in the eggs of ticks which causes tick-paralysis and the fungal and nematode parasites of mosquito larvae.

The Biochemical Department has done work on human nutrition, the nutrition of mosquito larvae, carbohydrate metabolism and the mechanism of action of sulphonamide methaemoglobinæmias.

The routine work of the Institute has again increased, although the military laboratories have taken over some of this. Further expansion of the Serum Production Department has been necessary. The large-scale serum-drying and freezing plant, the construction of which was borne by Sir Ernest Oppenheimer, has been completed and is in use. Very large quantities of vaccines have been produced. Typhoid endotoxin immunization in the Witwatersrand mines has reduced the annual incidence of typhoid since 1938 from 5.26 to 0.25 per 1,000 and the annual mortality from 1.18 to 0.05 per 1,000.

The reports of the branch laboratories at Port Elizabeth and Bloemfontein indicate that these are vigorously developing the work of the parent Institute. G. LAPAGE

AERIAL SYSTEMS FOR SHORT RADIO WAVES

A RECENT meeting of the Radio Section of the Institution of Electrical Engineers was devoted to the presentation of two papers dealing with theory and experimental performance of special aerial array systems for short and ultra-short radio waves.

The first paper was by E. B. Moullin and was entitled "Theory and Performance of Corner Reflectors for Aerials". For wave-lengths of about 10 metres, a convenient arrangement comprises a pair of reflecting sheets inclined to one another to form a V, with a single aerial on the bisector. Dr. Moullin shows that the field from such a system can be calculated by image treatment and that an algebraic formula can be found when the angle of the V is a proper fraction of 180°. A numerical example given in the paper illustrates the convenience of the Fourier series for evaluating the radiation pattern when the aerial is sufficiently distant from the apex to make the main beam much sharper than a sinusoid, and concurrently to produce side-lobes.

This paper also describes an experimental investigation at a wave-length of about 1.25 m of the radiation pattern produced by a half-wave-length aerial in a corner reflector with angles of 90°, 60° or 45°. Using one and a half wave-lengths high and two wave-lengths wide, it was found that the radiation distribution is not appreciably modified if the apex of the reflector is amputated and the resulting hole closed by a flat sheet. Such a modified reflector affords a saving in space and also shows that the pattern is insensitive to the shape of the back of the reflector. Her experiments showed that the performance of this type of aerial system was inappreciably affected when the continuous reflecting sheets were replaced either by wire netting with a mesh about one fortieth of a wave-length inside, or by a comb of open rods about half a wave-length long.

In the course of the second paper, H. Page described some measurements of the performance of various horizontal dipole arrays operating on wave-lengths in the region of 15–20 metres as used at stations of the British Broadcasting Corporation. The main method of measurement adopted consisted in elevating a calibrated frame receiving aerial by means of a captive balloon, by varying the height and position of the balloon, the field strengths in different directions from the transmitting array were determined. In a second method, a frame aerial at ground-level was used, this gave only relative values of field strength and was used mainly to determine variations in the performance of the aerial array as the radio frequency in use was altered over a small range.

It was found that for an aerial array radiating over a flat site free from obstacles, there was good agreement between the theoretical and measured performance: the maximum field strength was of the order 0.8–0.9 of the theoretical value. A sloping site or the existence of other nearby arrays may, however, cause appreciable departures from the theoretical characteristics. In particular, it was found that the loss of power in radiating through other aerial arrays may be as much as 40 per cent in some cases, and this loss is not necessarily associated with a resonant condition in the obstructing array.

It is concluded from this work that, in order to obtain the best efficiency in short-wave transmitting aerial arrays, these should be erected on as flat a site as possible and should be arranged to avoid radiation through other arrays, distant obstructions which intercept part of the main lobe of radiation could also be avoided.

'MINOR' ELEMENTS IN PLANT NUTRITION

OUR knowledge of the precise physiological functions of the so-called 'minor' elements in plant nutrition has not kept pace with the growing realization of their importance in agricultural and horticultural practice. A number of papers in the *Proceedings of the American Society of Horticultural Science* report the effects of certain minor elements on crop growth and behaviour. R. D. Dickey and J. Drossdoff (42, 74, 1943) show that 2 lb of manganese sulphate per tree applied to the soil cured yellowing of the leaves of the tung (*Aleurites fordii*), due to manganese deficiency. The same authors

(42, 79, 1943) describe a 'cupping' of the terminal leaves of the tung, which are reduced in size and show an interveinal chlorosis and sometimes an apical and marginal browning. This may be followed by leaf abscission and shoot die-back, the condition can be cured by applying copper sulphate (1/16 oz per tree) to the soil. That the disease is due to copper deficiency and the ameliorative effects of the soil dressings of copper sulphate are not due to any indirect effect, is shown by the fact that spraying with copper sulphate is equally effective in curing the disease.

J. G. Maclean, W. C. Sparks and A. M. Binkley (44, 362, 1944) in a manurial experiment with potatoes in an alkaline soil (pH 8.5) supplied the sulphates of iron, copper, zinc and manganese (25 lb per acre) alone and in all possible combinations, in addition to adequate dressings of nitrogen, potash and phosphate. Besides noticeable effects on crop yields due generally to effects on tuber size rather than the number of tubers, all the treatments, except copper + iron + zinc, copper + zinc + manganese, iron + zinc, copper + manganese, and zinc + manganese, increased the thickness of the periderm of the tuber significantly. Whether or not a thickened periderm will reduce tuber damage during harvest and marketing remains to be seen, but the possibilities in this direction need no stressing. Effects of minor elements on skin colour of tuber of Red McLure potatoes are reported by W. C. Sparks (44, 369, 1944), who found that all combinations of minor elements tried increased tuber colour in the field, but the effect was greatest when iron, alone or in combination with copper or copper and manganese, was supplied.

Significant effects on carrots and turnips of application of borax, copper sulphate, manganese sulphate and zinc sulphate, to soils in which the crop showed no deficiency symptoms, are described by G. H. Harris (43, 219, 1943). The effect varied on the different soils (but copper always increased root yield) and yield, sugar content and keeping qualities of the roots were all affected by the treatment.

CYTOPLASM, VACUOLE AND CELL-WALL MAGNITUDES IN DIPLOID AND TETRAPLOID BARLEY

IN the larger cells of a 'gigas' or 'semi-gigas' allo-tetraploid, is the increase due to proportionate increases in the cytoplasm, the vacuoles and the cell-walls, or is it mainly due to an increase in one alone or in two of these? By careful analyses of the water, ash, sugar, 'protein', nitrogen, etc., contents of diploid and tetraploid plants of a single variety of barley, *Hordeum vulgare*, grown under constant nutrient conditions in photothermostats, I. Ekdahl (*Arkiv för Botanik* (Stockholm), 31, No 5, 1, 1944) is able to draw some interesting conclusions. Tetraploid leaves assimilate more slowly but have a higher proportion of their dry weight as sugar and ash than diploid leaves, but if this extra sugar and ash is deducted from the total dry weight, a 'residual' dry weight for 'protein', cell-wall, etc., is obtained which is the same in both tetraploid and diploid leaves. Calculated on the residual dry weight, fresh tetra-

ploid leaves contain about 30 per cent more water than the diploids, the roots, on the other hand, have approximately the same composition in tetraploids and diploids, whether calculated on fresh weight or residual dry weight. Thus, "The difference between the leaf structures of tetraploid and diploid barley, apart from the difference in volume, appears to be that the tetraploid leaf cells contain comparatively more water, sugar and ash, while the amounts of cytoplasmic substances are proportionally the same. In the root cells it is mainly only the cell volume which is changed."

By correlating the analyses with measurements of the cell dimensions in a number of organs and tissues, it seems that when the cell volume increases as a result of doubling the number of chromosomes, in the leaf, the 'thickness' of the cytoplasmic layers and cell walls is uniformly increased but not to the same extent as the cell dimensions, that is, the cells have a larger proportion of their volume as vacuole. In the roots, however, the 'thickness' of the cytoplasmic layers and cell-walls increases to the same degree as the general cell dimensions.

FORTHCOMING EVENTS

Monday, January 22

INSTITUTION OF ELECTRICAL ENGINEERS (at Savoy Place, Victoria Embankment, London, W C 2), at 5.30 p.m.—Discussion on "Applications of Electricity to Water Supply" (to be opened by Mr J F Shipley)

Tuesday, January 23

INSTITUTION OF CIVIL ENGINEERS (at Great George Street, Westminster, London, S W 1), at 5.30 p.m.—Mr S R Raffety "Rural Water Supplies"

ROYAL AERONAUTICAL SOCIETY (at the Institution of Mechanical Engineers, Storey's Gate, St James's Park, London, S W 1), at 5.30 p.m.—Discussion on "Civil Aviation"

Tuesday, January 23—Wednesday, January 24

IRON AND STEEL INSTITUTE (joint meeting with the LINCOLNSHIRE IRON AND STEEL INSTITUTE) (in the Technical School, Cole Street, Souththorpe), at 7.30 p.m.—Mr G D Elliot "Ironmaking at the Appleby-Frodingham Works of the United Steel Companies, Limited"

Wednesday, January 24

ROYAL SOCIETY OF ARTS (at John Adam Street, Adelphi, London, W C 2), at 1.45 p.m.—Mr James B Firth "Forensic Science"

SOCIETY OF CHEMICAL INDUSTRY (joint meeting of the PLASTICS GROUP with the BRITISH RHEOLOGISTS' CLUB and the FARADAY SOCIETY) (at the Institution of Mechanical Engineers, Storey's Gate, St James's Park, London, S W 1), at 2.30 p.m.—Dr G W Scott-Blair "The Rheology of Plastics"

TELEVISION SOCIETY (joint meeting with the RADIO SECTION OF THE INSTITUTION OF ELECTRICAL ENGINEERS) (at the Institution of Electrical Engineers, Savoy Place, Victoria Embankment, London, W C 2), at 5.30 p.m.—Mr Donald G Fink "American Television Broadcasting Practice, 1927-1944"

BRITISH ASSOCIATION OF CHEMISTS (BIRMINGHAM SECTION) (in the Large Hall, Chamber of Commerce, New Street, Birmingham), at 6.30 p.m.—Discussion on "Social Security for Chemists"

Thursday, January 25

LONDON MATHEMATICAL SOCIETY (at the Royal Astronomical Society, Burlington House, Piccadilly, London, W 1), at 3 p.m.—Prof J Hadamard "Psychological and Personal Recollections of a Mathematician"

Friday, January 26

INSTITUTION OF MECHANICAL ENGINEERS (at Storey's Gate, St James's Park, London, S W 1), at 5.30 p.m.—Mr J Foster Petree "Mechanical Engineering in the Shipyard" (Seventeenth Thomas Lowe Gray Lecture)

INSTITUTE OF FUEL (SCOTTISH SECTION) (at the Royal Technical College, Glasgow), at 5.45 p.m.—Dr J M Ferguson "The Insulation of Open-Hearth Furnaces and Blast-Furnaces"

Saturday, January 27

ASSOCIATION FOR SCIENTIFIC PHOTOGRAPHY (at Caxton Hall, Westminster, London, S W 1), at 2.30 p.m.—Mr H K Bourne "Electric Discharge Lamps for Photography"

APPOINTMENTS VACANT

APPLICATIONS are invited for the following appointments (before the dates mentioned)

SENIOR EXECUTIVE ENGINEER by the Public Works Department—Trinidad—The Ministry of Labour and National Service, Cc (T and S) Register, Room 5/17, Sardinia Street, Kingsway, London, W C 2 (quoting Reference No E 1304 A) (January 24)

ENGINEER for the Public Works Department, Government Trinidad—The Ministry of Labour and National Service, Cc (T and S) Register, Room 5/17, Sardinia Street, Kingsway, London, W C 2 (quoting Reference No E 1299 A) (January 25)

HEAD OF THE DEPARTMENT OF SCIENCE of the South-East J Technical College and School of Art, Dagenham—The Chief Education Officer, County Offices, Chelmsford (January 27)

PLANT ENGINEER (must have general scientific educational background, degree in physics or mechanical engineering, some previous engineering experience essential) by a firm in Middlesex—The Ministry of Labour and National Service, Central (T and S) Register R 5/17, Sardinia Street, Kingsway, London, W C 2 (quoting Reference No C 2321 XA) (January 27)

CONTROLLER OF MATERIALS in the Directorate-General of Air in India—The Ministry of Labour and National Service, Cc (T and S) Register, Room 5/17, Sardinia Street, Kingsway, London, W C 2 (quoting Reference No C 2430 A) (January 30)

ASSISTANT TO THE ADVISORY CHEMIST for the South Eastern Province under the scheme of the Ministry of Agriculture and Fisheries—The Acting Principal, South-Eastern Agricultural College, Ashford, Kent (January 30)

SENIOR RESEARCH CHEMIST with experience in manufacture or research on petroleum products (Reference No F 2777 XA) RESEARCH CHEMIST with chemical engineering qualifications (Reference No F 2778 XA), and a RESEARCH CHEMIST with laboratory experience in petroleum or heavy chemicals (Reference No F 2779 XA) in the Research and Development Department of a British Oil Company at its Refinery in N W England—The Ministry of Labour and National Service, Central Register, Room 5/17, Sardinia Street, Kingsway, London, W C 2 (quoting the appropriate Reference No) (February 12)

ASSISTANT ENGINEERS (temporary) by the Kenya Government Public Works Department, for water supply schemes—The Ministry of Labour and National Service, Appointments Department A 3 (Room 5/17, Sardinia Street, Kingsway, London, W C 2 (quoting Reference No E 1317 A) (February 12)

UNIVERSITY READERSHIP IN LOGIC AND SCIENTIFIC METHOD, tenable at the London School of Economics and Political Science—Academic Registrar, University of London, c/o Richmond College, Richmond, Surrey (February 26)

LECTURER IN VETERINARY PARASITOLOGY—The Registrar, University, Liverpool (February 28)

DIRECTOR OF MUSEUMS—The Town Clerk, Municipal Buildings, Dale Street, Liverpool 2 (February 28)

CHAIR OF GEOGRAPHY, and the CHAIR OF GEOLOGY—The Registrar, The University, Sheffield (March 31)

UNIVERSITY READERSHIP IN ENTOMOLOGY, tenable at the London School of Hygiene and Tropical Medicine—The Academic Registrar, University of London, c/o Richmond College, Richmond, Surrey (July 31)

ASSISTANT (medical graduate) IN ANATOMY—The Secretary, University, Aberdeen

REPORTS and other PUBLICATION

(not included in the monthly Books Supplement)

Great Britain and Ireland

Scheme for a Degree Course in Chemical Engineering (London Institution of Chemical Engineers) Higher Appointment of the Ministry of Labour and National Service Report of the Committee appointed by the Minister of Labour National Service for the Year 1943 (Cmd 6576) Pp 62 (London Stationery Office) 1s net

Other Countries

Bulletin of the Bingham Oceanographic Collection Vol 9, Art Studies on the Marine Resources of Southern New England, 1 Analysis of the Fish Population of the Shore Zone By Herbert Warfel and Daniel Merriman Pp 92 (New Haven, Conn Peabody Museum of Natural History, Yale University) 1.50 dollars
Annual Report of the Imperial Council of Agricultural Research for 1943-44 Pp ii+44 (Delhi Manager of Publications) 2 rupees 3s

Republica Argentina Ministerio de Agricultura, Direccion Meteorologia, Geofisica e Hidrologia Serie E, No 1 El Ter Centenario del Barometro Pp 12 (Buenos Aires Ministerio Agricultura)

Indian Forest Leaflet No 65 Conditioning Chamber for Plywood By M A Rehman Pp ii+3 (Dehra Dun Forest Research Institute) 6 annas, 7d

Food is Where you Find It A Guide to Emergency Foods of Western Pacific By Lucy M Cranwell, Josiah E Green and A W Powell Pp 72+4 (Auckland Auckland Institute and Museum)

Seventeenth Annual Report of the Council for Scientific and Industrial Research, for the Year ended 30th June 1943 Pp 76 (Cberra Commonwealth Government Printer) 3s 4d

Papers of the Michigan Academy of Science, Arts and Letters 20 (1943) Pp xii+606 (Ann Arbor, Mich University of Michigan Press, London Oxford University Press) 5 dollars, 28s net

New Zealand State Forest Service Annual Report of the Director of Forestry for the Year ended 31st March 1944 Pp 38 (Wellington Government Printer) 1s

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SCIENCE AND HUMANITY

ANY doubts as to the value of the Conference on "The Place of Science and Industry", arranged by the British Association in January 12 and 13, should have been removed by Lord Woolton's well-deserved tribute to the way in which the educational work of the Association in the field of nutrition, carried out over the ten years following Sir F. Gowland Hopkins' presidential address at Leicester in 1933, had prepared the public mind for the food policy which averted the threat of definite food shortage in Britain soon after Lord Woolton took office in April 1940. People had come to realize that nutrition, far from being a fad, was the plainest of common sense. A nutrition policy which aimed at distributing food on the basis of its nutritional value, not its capacity to satisfy appetite, so that the vulnerable classes—mothers, expectant mothers, infants and children and heavy workers—should have full protection, and the rest of the population should have a physiologically adequate diet, had met with the approval and support of the public. Further, such a policy is in a fair way to become a permanent part of the food policy of Britain. The immense benefit to the nation's health and the actual raising of the pre-war standard even under stress of war have already been generally recognized, and if other speakers besides Lord Woolton dwelt on the point, it was rather to stress the folly of lightly abandoning such a solid advance, and to indicate the immensely greater possibilities which the further extension of scientific research in this and in related fields and its application in practice and policy hold for the future.

What is true in this important field of food and nutrition is true in other fields. The effective application of science to social and industrial affairs involves the understanding and support of the general public. In discussing scientific and industrial research in these columns last autumn (cf. *Nature*, 154, 407, 1944), it was pointed out that the expansion of such research to the scale required involves a clear and widespread public understanding of its purposes and implications. It is as a contribution to the task of public education that the Conference is important, and both Sir Richard Gregory and Sir Harold Hartley were at pains to stress this point. The Conference was not just another in the long series of debates, discussions and reports on this subject in the last two or three years: it was a step to further public education, on which the expansion of research depends.

Even such a brief account of its proceedings as is printed in the present issue of *Nature* (p. 96) gives some idea of the justice with which it can be claimed that the Conference has helped to prepare the public mind for what is involved in the expansion of scientific and industrial research to the scale imperative for an adequate attack on post-war problems. When the full report of the Conference is published, it will provide scientific workers generally with much material to assist in the task of educating the public. The Association can rarely have assembled an array of speakers so imaginatively alive to the issues, so able in exposition and in interpretation and, it may

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be remarked, so clear in delivery. Even the more commonplace papers showed no lack of honest workmanship, and should be equally useful in the task of further public education.

The papers which touched on food and nutrition illustrated two further characteristics of the Conference—the dynamic character of the relations between science and industry, and the strong emphasis on the social factors, both in the prosecution of research and in the application of its results. The continued reaction of science on industry and of industry on science, the way in which industry stimulates science as well as science industry, or in which one industry stimulates another, was apparent in one field after another. Whereas Dr W. T. Astbury linked the textile industries with the advance of biology and the plastics industry, Prof J. M. Mackintosh summoned not merely the biologist and the chemist but also the mechanical expert and the plastics industry to the help of the surgeon.

The Conference thus provided a powerful demonstration that we cannot wisely tolerate stagnation in any field of industry, and that we must seek to promote advance along the whole industrial and scientific front so as to maintain a proper balance. But there must also be a fuller measure of co-operation and a further attempt to integrate knowledge both in the scientific and technical field. Here again it was urged that we should learn the lessons of the war years and apply them to the tasks of peace, and Sir Lawrence Bragg uttered a wise warning against mistaking the means for the end. The material achievements which science makes possible—rapid communication and travel, power and command over materials—are making the world a higher type of organism with a more complex nervous system and greater division of function. But the material and technical achievements must be seen against the cultural and moral background, so that we can diffuse that wide understanding of science which is the best safeguard against its misuse, and the surest inspiration to the service of society.

That idea, never entirely absent, came most insistently to the front in the final session. The importance of the social motive as a stimulus to research explicitly stressed by Mr E. Carter was implicit in all the other papers, though in Sir Lawrence Bragg's the emphasis was rather on its value in attracting to industry men of the highest calibre. There was general agreement as to the shortage of men of the highest capacity for the main fields of research to be pursued, and while there was some uncertainty as to how far Sir Lawrence Bragg was right in this particular contention, the changed outlook, the emphasis on serving the needs of the consumer rather than on the profit motive, and the recent developments of economic science, all trend in the right direction of increasing the attractiveness of a scientific career in industry, on the importance of which, from different points of view, so much stress was laid throughout the Conference. With all the emphasis on industrial efficiency, this was viewed against the right background and interpreted in no narrow financial or mechanical sense, but as covering the social efficiency

also—the extent to which an industry can serve the needs both of the workers it employs and of the community, industrial or social, the wants of which it is its prime purpose to supply.

Here as elsewhere there was vision and imagination. The Conference was undoubtedly a step to supply the publicity for which such reports as that of the London Chamber of Commerce last year so insistently call—the stimulation of public interest in scientific work and the interpretation to the public of the results that work in industry. Certainly it demonstrated that we have the capacity to combine science with practice in industrial development, and that increased contacts will ensure the advancement of both. But more than this, the Conference was of importance in the field of public relations. The dynamic picture of the relations between science and industry unfolded in its sessions, the imaginative glimpse of the possibilities before us in the post-war world, the way we harness aright knowledge and power, cannot but make for closer understanding between the parties concerned, whether management and labour, the industrialist, the Government administrator, the scientific worker in the university or in industry, the producer and the consumer. Above all, it is a great challenge to the scientific worker himself, in whatever branch of science, pure or applied, he may be engaged, to explore more fully, more patiently, more resolutely and imaginatively those many fields where knowledge is still lacking, not least where new knowledge and creative thought may contribute most swiftly and significantly to the evolution of the new forms of organization which may be required to serve the needs of to-morrow, and to place freely and fully at the disposal of all the rich resources and wide powers which science is giving us to command, while safeguarding the freedom and culture which are our most precious inheritance.

HUMAN SEX HORMONES

The Hormones in Human Reproduction

By George W. Corner. Pp. xix + 265 + 24 plates (Princeton, N.J.: Princeton University Press; London: Oxford University Press, 1942) 18s. 6d. net.

BIOLOGY teachers are soon going to be confronted with the problem of bringing up to date text-books on a number of subjects, particularly those which have not previously been well presented to the student. Curiously enough, there are few works which provide an authoritative introductory account of the factors underlying human reproductive processes. This is partly because the interval between the War of 1914–18 and the present War was one of very active research, in which most people with first-hand knowledge of the subject were too absorbed in experimental work to turn to the task of summarizing the progress which research was making. Prof. Corner's book on the hormones in human reproduction is therefore most timely, for it is at once a concise and a comprehensive exposition of the subject, given by one of the foremost contributors to knowledge in the field of physiology. The book was published in the United States in 1942, but, as relatively little new has since emerged in this line of research, it provides as up-to-date a general treatment of the subject as

ld now be desired, and in so doing fills a very
gap

The book is, however, much more than a useful
text-book. It is a fascinating story which will also
give of interest and value to the lay reader. Here
it answers a long-felt need for a simple but
accurate outline of the processes of reproduction,
presented in a form which is both intelligible and
attractive to the non-scientific public. This in fact,

Prof Corner tells us in his introduction, was his
main purpose in writing the volume, which was built
around the Vanuxem Lectures he gave at Princeton
February 1942—lectures intended not for specialists
but for a mixed university audience. His aim has
been brilliantly realized, for the book is all that
can be asked of a general presentation of a complicated
subject. It is brief, it eliminates unessentials, it
carries the reader gradually into each topic by show-
ing what the problems were that had to be solved
at each step, and, over and above all, its style is
not that of a scientific treatise but of a literary work.
The romance of discovery is colourfully illustrated,
particularly in the chapter which deals with the
oestrogenal hormone, a field of inquiry which will
ways be associated with Corner's name. It also
indicates the established limit of knowledge by show-
ing where present researches promise to break new
ground.

The volume opens with a general statement about
sexual and asexual reproduction in the animal world.
The second chapter considers the human egg, and
the organs that make and care for it. The third
deals with the periodicity of ovarian activity, and
discusses variations in the sexual cycle in mammals.
The chapter which follows is a fascinating account of
the discovery of the oestrogenic hormones, and of
their action. Chapter 5 deals with the hormone of
the corpus luteum, which is responsible for the uterine
changes that permit the implantation of the fertilized
ovum. In this chapter Corner gives a most lively
summary of the part he played in the story, and of the
difficulties which had to be overcome. However
heartening it may have been at the time, one can
only appreciate the lighter side of the episode he
relates—how he was racing up the steps of his labo-
ratory at Rochester, carrying a glass syringe which
contained the world's entire supply of crude pro-
gesterone, when he stumbled and fell, and lost it all.
The chapter which follows deals with the endocrine
control of the menstrual cycle, and gives a very
balanced statement of this difficult question. Next
follows a chapter on endocrine arithmetic, which
presents some novel calculations about the amount
of sex hormones produced daily in the body, then
a chapter on the hormones of pregnancy, and finally
one on male hormones. The brevity of Corner's
account of the male side of reproduction is perhaps
the only feature which one can regret in the book.
Each chapter considers the clinical applications of
the sex hormones, and each is excellently illustrated.

While, as Prof Corner tells us, the volume was
written primarily for the layman, it is certain that
it will also be widely used by the student as an
introduction to a growing branch of knowledge. Quite
apart from the function which it is likely to serve
in this way, it will undoubtedly, because of its de-
lightful presentation, attract to the subject new
research workers, who will discover from it at least
many problems to engage their attention as those
which he has so admirably elucidated.

S ZUCKERMAN

SEX EDUCATION AND GUIDANCE

Sex Education

A Guide for Parents, Teachers and Youth Leaders.
By Cyril Bibby. Pp xi+291 (London: Macmillan
and Co., Ltd., 1944) 7s 6d net.

HOW thorny the question of sex is to the adult
mind is aptly symbolized by the myth of the
gooseberry bush, and the consequences of the con-
spiracy of silence are seen by doctor and psychiatrist.
It is, however, a truism of practice that none but
serious cases come for treatment, and much daily
friction and maladjustment arising from unresolved
sex conflicts does not reach the consulting room. Few
indeed are the adults who cannot recall from their
own adolescence periods of intense psychic pain which
greater enlightenment might have spared them, more
fail to achieve harmony in marriage and that libera-
tion of energy which comes of an unclouded mind,
not because they were born abnormal, or because
adjustment to modern conditions is impossible, but
because, at critical periods of psychic development,
they lacked the right emotional attitude towards
manifestations of their own sexuality.

As yet, we have not had a generation of parents
in whose outlook sex problems and interests take as
natural and unexaggerated a place as questions of
dietetics or physical exercise. We cannot, therefore,
say that a sound sex education will be a panacea for
the mental ills of society. Indeed, experience with
the neuroses of the War of 1914-18 has shown that
conflict between *any* innate instinctive impulse and
the environment may bring about neurotic dys-
function. With confidence, however, we can assert
that a system of education which strips sex of the
shameful glamour which decorates walls with obscene
epigraphy, and presents it as something natural and
healthy like breathing, eating and sleeping, will
diminish tension and conflict and contribute to happi-
ness and efficiency. That this is very largely now
an accepted thesis among educationists and even
among the majority of laymen represents a broad
advance of great moral and ethical significance.

It remains for the educationist to meet the prac-
tical difficulties of applying the principle. Mr Bibby's
book is an attempt to do this in a comprehensive way.
Recognizing that sexuality is coterminous with life
itself and pervasive of all aspects of the personality,
he does not rest content with mere training. His
suggestions cover the whole education of the child,
the youth, the adolescent and the young adult. For
him, sex education is a preparation for life itself, not
a matter only for the biology lesson or an allusive
discussion of the pollination of flowers. A beginning
should be made in the nursery, not alone on the
basis of imparted facts—though these are important
—but in the creation, by parental precept and atti-
tude, of a right outlook. The school-child should
already have received an emotional and factual
education on this topic on which the teacher can
build with confidence his more specific training.
Literature, religion, geography, history and even
mathematics—all subjects of the curriculum—can then
be laid under contribution in the building up of a
generation emancipated from dark mystery and
happy in a deeply ingrained habit of control.

This, Mr Bibby recognizes, is an ideal, though not
perhaps too remote. Few, as yet, have the necessary
knowledge or the fundamentally sound emotional
attitude necessary for the instruction of their children
in the earliest stages of life. At present, therefore,

the task devolves largely upon the teacher and youth club leader. His book is a guide for bridging the transition period between the present and a future of fully enlightened parents. How practical it is can be seen by the appendixes, which contain specimen lecture material, suggestions for concrete activities and a tentative but comprehensive scheme for sex education throughout the whole early period to full maturity and parenthood. The body of the book contains sound advice, documented by references to research, and illuminated with well-chosen examples of questions put by children, adolescents and adults. Particularly valuable to the parent is Chapter 3, which swiftly and effectively deals with the major problems of sex as they arise in the home and which may well clear away cobwebs in the adult mind. The discussion which follows, of the place of sex education in the school curriculum and the kind of teaching appropriate to the various stages of development, is based upon unimpeachable psychological and educational principles. Chapter 6, which gives a brief outline of the changes, intellectual, emotional and physical, of adolescence will have special significance for youth leaders and all who have to do with boys and girls in that most critical of all phases.

The book is comprehensive in scope and framed to meet the needs of the intelligent but not specially instructed reader. This, however, does not mean that it is either superficial or elementary. Indeed, it might well be recommended as a text-book on the educational aspects of sexology. The bibliography will introduce the interested reader to literature of more specialized kinds, and the author's brief comments on the books he recommends will be found of the greatest value. It is a pity that an index is not provided, for, although the author seeks to justify the omission in his introduction with the plea that his subject must not be viewed piecemeal, this reviewer feels that a speedy reference to particular passages would be of value to the busy teacher, the more so since many topics are dealt with in their several aspects in different parts of the book. An index would serve to bring together all that the writer has to say on any important aspect of his subject. A further point concerns the vexed question of acknowledging the source of quotations and references. Mr Bibby has obviously drawn extensively upon the work of others; lengthy footnotes are out of place in a book like this, but it would be helpful to the reader who wishes to pursue the subject, if sources and page references were given.

These, however, are small criticisms of a book so sane and moderate in its outlook, so much needed at the present time, and so calculated to further both the general cause of education and the more specific purpose of spreading enlightenment and banishing prejudice.

W D W

THE SPIDER'S WEB

La toile géométrique des araignées

Par André Tilquin. Pp 536+8 plates (Paris: Les Presses universitaires de France, 1942) 150 francs

IN this work Dr. A. Tilquin sets out the results of six years' research on the making of the familiar orb-webs spun by spiders of the family Argiopidae, and it may be said at once that the book is well worth the attention of all, whether arachnologists or not, who are interested in the study of instinctive behaviour.

The author begins by clearing away any psychical

factors. He finds it impossible to detect any evidence of mental relationship between a man and a spider of the kind which is common between a man and a dog. Whereas to the dog his master seems to appear as an individual, to the spider a man represents more than a source of shade or warmth, so that all its life the spider never shows more recognition of man than is expressed in an inhibition of the retreating from its web at his approach. Clearly, therefore, a mechanistic description of web-making is to be expected throughout.

The difficulty of getting Argiopidae to make normal webs in captivity has been overcome by providing each spider with an isolated wooden framework, in which the web is fixed. An Argiopid spider, it is clear, must have sufficient space for its operations, which cannot be reduced to a smaller scale, and Dr. Tilquin has devoted two rooms in his house to this accommodation. More than a dozen species have been kept under observation, but most of the work has been done with *Argiope brunnichii*.

Two chapters are occupied by a description of the web, an accurate analysis of its constituent parts and their variation among different species, for the author observes that a minute study of web-structure made independently of the actions of the spinner, the best introduction to the study of these activities themselves. It clarifies the problems set and points the way to their solution.

Chapter 3 is chiefly a consideration of experiment on the influence of light and gravity in determining the direction of the *fil suspensorius*, or the strong cable from which the web hangs and which forms the upper limit of the whole field of operations. The next two chapters deal with the construction and spacing of the radii. A new conception is introduced here, namely, that solid and stable points of support exert an attraction for the spider, whereas unstable flexible ones are less attractive or even repeller. This determines the distance of the hub of the web from the *fil suspensorius*, and so affects the area and symmetry of the circular portion. It also influences the angles between the radii, so that often the angles have different values above and below an approximately horizontal middle line. These chapters expound Dr. Tilquin's concept of the web as a *char dynamique*, an area in which forces of attraction and repulsion are at play, and the spider is moved into equilibrium with their resultants.

The next three chapters apply this hypothesis to the laying down of the temporary spiral, its removal and replacement by the viscid spiral. The effects of age, sex, moulting, mating and egg-laying are included, and form one of the most original portions of the monograph. A chapter follows on the special features peculiar to the webs of a single genus or species, and the tenth chapter is a general summary. It is characteristic of Dr. Tilquin's methods that here he introduces the term *sérocophilie* to describe the spider's apparent preference for touching silk rather than anything else—for example, the spider's foot placed on the thread which leads from the hub of the web to its hiding-place, is exhibiting *sérocophilie* rather than awaiting the occurrence of vibrations.

Dr. Tilquin, writing of these and other matters with an almost excessive attention to detail, has made an advance on the researches of Peters and Wiehle, both of whose theories he criticizes, and has made a notable contribution to our understanding of an object which is unique among the products of animal industry.

T. H. SAVORY

Building Illustrated

Being an Introduction to Standard Building Methods
By W. H. Smith Pp viii+112 (London: E. and F. N. Spon, Ltd., 1944) 16s 6d.

THE value of the attractive paper cover on this book has been made useless by the numerous mistakes which appear on it. For example, and here I quote from a copy of by-laws with respect to new streets and buildings: "Each external wall shall be provided with an effective damp proof course at a height of not less than six inches above the surface of the adjoining ground." The damp proof course shown on the paper cover is just over three inches above the ground-level.

The orthographic drawings have not been made in accordance with the British Standard Specification Drawing Office Practice. To give examples, the sections of Figs 29, 82 and 86 want turning over so as to be in correct projection, and plain lines should have been used for all measurement lines instead of broken lines as shown throughout the book.

Now a word or two about windows. The pulley stile in detail A, Fig 83, wants turning over so that a proper tongued and grooved joint is made.

The freakish *S* which pervades the drawings should be avoided by students when printing the titles, as this is more often mistaken for an *F*.

There are two particularly good chapters, one is on drainage and the other on defects found in buildings.

A. S. EMERY

An Introduction to Philosophy

By W. A. Sinclair Pp. 152 (London, New York and Toronto: Oxford University Press, 1944) 5s net

THIS clear and well-reasoned introduction starts from the classical problem of modern philosophical thought—sense perception and the knowledge we take to be based upon it. For the scientifically trained reader this is probably the best approach, though not necessarily for other readers. By his method of treating the subject Mr Sinclair challenges comparison with Russell's well-known "Problems of Philosophy" and survives the test very well. He scarcely has the lightness of touch of his predecessor, but he is rather more systematic and is better at indicating further possibilities and other inquiries. The footnote references to important thinkers are well done. The advice for further reading is refreshingly unconventional, but not well balanced, and what is said about Plato and Greek philosophy is definitely misleading.

A. D. R.

Proceedings of a Conference on Problems in the Utilisation of Small Coals

Held at the Institution of Civil Engineers, November 10th and 11th, 1943 Pp 294 (London: British Coal Utilisation Research Association, 1944)

IT is inevitable that incombustible matter accompanies coal arriving at the pithead and in varying degrees of association, depending on the quality of the seam. From this point follows a series of cleaning processes—dry and wet—which in general aim at the removal of dirt and fine coal. Water is usually necessary, and as a consequence the colliery must dispose of the unwanted residue of the cleaning process which contains an undesirable proportion of water. This residue, commonly known as 'slurry', consists of coal which contains too much incombustible matter, too much water and at the same time is too fine in size to have commercial value. This com-

bination of physical conditions imposes such difficulties that remedial measures to convert 'slurry' into salable fuel are in normal times unremunerative, but this is only a relative term, for the quantity of this waste of potential value is enormous—many millions of tons—which in times of scarcity is actually used. It may be that the days when this fuel can be so lightly discarded as hitherto have already passed for ever. It must be recognized that the mining industry has in the past given much attention to the problem, as will be evident from the present report on the conference on the utilization of small coals, at which twenty-eight papers were presented. These give a measure of work done, while a visit to the surface workings of a colliery will reveal the scope of the task of disposing of the wet, dirty fine coal which is produced. There is another if somewhat different problem in the disposal of fine coke.

H. J. HODSMAN

A Handlist of News Pamphlets, 1590-1610

By Dr D. C. Collins Pp xx+129 (London: South-West Essex Technical College, Walthamstow, 1943) 10s 6d

THIS admirably produced little volume is in two parts: first, a handlist of news pamphlets printed between 1590 and 1610 and still extant, and secondly, a list of such pamphlets printed between 1590 and 1610 and entered in the Stationers' Register, but not now extant. The first list is annotated, the contents being indicated where the title is insufficient, and the comments show the significance of the item. The list is arranged chronologically, and within each year according to the date of entry in the Stationers' Register. Surviving pamphlets not entered in the Register follow the last entered copy surviving for each year. Where more than one copy of the pamphlet survives, the British Museum copy has normally been used. Other copies used are indicated by a reference letter, but the names of libraries possessing a single unique copy are given in full. If the copy for the transcript is one not recorded in the Short Title Catalogue, the press mark of the library is given. Both the Short Title Catalogue number and the date of entry of the pamphlet in the Stationers' Register and the high standard of bibliographical detail should make the list the more valuable and welcome for research into the collection and dissemination of news during the period covered. Its value and purpose in this respect are concisely explained in Dr Collins' excellent introduction.

Get to Know Yourself

A Series of Psychological Tests. By Joseph Ralph Pp iv+89 (London: Chaterson, Ltd., n.d.) 3s 6d net

A PART from the suggestion in the title that more self-knowledge is desirable and a few sensible remarks here and there, this book has little to commend it. The author sets out a series of so-called self-rating 'tests' of nineteen 'dispositions'. Numerical weights, determined presumably by the author's inner consciousness, are attached to each test item. Norms suggested have an equally subjective quality. The term 'test' is certainly a misnomer for a set of overlapping and equivocal questions unstandardized or scaled in any way. The alleged 'dispositions' are nothing more than a mixed series of popular catch-phrases. No substantiation is given of the claims on behalf of the tests in the prefatory note.

J. C.

THE PLACE OF SCIENCE IN INDUSTRY

AS was stressed by Sir Richard Gregory in his introductory address, and again by Sir Harold Hartley in summing up at the final session, the two-day conference on "The Place of Science in Industry", arranged by the Division for the Social and International Relations of Science of the British Association on January 12 and 13, and held at the Royal Institution, was no mere repetition of discussions on scientific and industrial research, or the relations of science and industry to be found in numerous recent reports. It could not be claimed that fresh ideas in regard to the strategy and tactics of research or its organization were ventilated at the Conference, though some of the war-time achievements of science were disclosed for the first time to a wider circle. The subject was viewed essentially in its social setting, and the Conference was a definite attempt to further that task of public education upon which the adequate support of research depends. Unless there is general understanding of the achievements and the possibilities of scientific research, we cannot expect that there will be forthcoming the public support, either of finance or of men, on which the expansion of our scientific effort to meet the post-war demands and opportunities ultimately depends.

As Sir Harold Hartley pointed out, the Conference had two main objects—to give the public a detailed idea of the contributions of science in industry, and to give a clearer view of what should be our strategy and tactics in this field. Its organization was thus in harmony with the educational work of the British Association in the field of nutrition to which, at the final session, Lord Woolton paid such a generous and emphatic tribute. If a tribute no less emphatic and generous should be paid to the Association by some future Minister of Production for its work in this field in promoting general interest and understanding of the place and application of science in industry, it may well be for the balanced and lucid presentation of the subject which characterized the recent Conference.

Sir Richard Gregory dealt with some of the popular misconceptions of the past and referred to the impossibility of a sharp separation between research workers, in pure and in applied science, or again of separating scientific workers from other citizens in their social duties and responsibilities. He urged that there must be a two-way traffic between science and industry if we are to be in the van of progressive life and service. Advances on this united front would raise standards of living and strengthen the social structure if they are correlated with humanistic national policy. Public opinion would not now tolerate the deplorable social effects of the introduction of new powers and processes of a century or more ago.

Referring even more emphatically than Sir Richard Gregory to the lag between scientific knowledge and social wisdom, Mr. Ernest Bevin, who presided over the first session, on "What Industry Owes to Science", commented on the greater receptivity of industry to scientific ideas in war-time than in time of peace. The time lag, he believes, is due partly to faults in the management or directorate in industry, and partly to traditions of the past. He urged closer study of the problem of how best to bring the benefits of scientific discovery into the lives of the people so that they can be enjoyed by the masses as quickly as possible and at a price within their reach. The

people should, as it were, have a vested interest in a scientific discovery.

Following on Mr. Bevin's plea for social and economic research—and it was notable that the Conference was never allowed to forget such aspects—the session considered some of the industrial achievements of science in a way which should win the support of any trade unionists who tend to look askance at science. Lord Brabazon's dry humour played delicately over the achievements of aviation, emphasizing the immense potentialities opened up by jet propulsion with its gas engine, revolutionizing aeroplane design and speed, with possibilities as power units in other fields. He referred to the important part which the universities must take in such fields, the necessity of full freedom for the fundamental research worker, with no dictation as to the detailed direction of his work. Sir Robert Watson-Watt followed with a paper on telecommunications, in which once again the repercussion on, and stimulation of, other industries by research in a particular industry was stressed. Distinguishing between the internal science and external science with reference to an industry, the former being scientific effort oriented towards the direct solution within the parent technique of the industry of problems peculiar to the industry, Sir Robert said that the telecommunications industry has been exceptional, and exceptionally fortunate, in its utilization of external science. He instanced the demands it has made on the metallurgist for metals, on the inorganic chemist for dielectrics, basic materials and coatings, and glasses which 'wet' the metals used in the vacuum tubes, on the organic chemist for dielectrics for cables, on the crystallographer, the electron physicists, on those expert in classical optics, acoustics, geophysics and solar physics.

Much the same, if less extensive, stimulating interplay between industry and the sciences and between industries was revealed in Dr. W. T. Astbury's paper on synthetic fibres. Dr. Astbury pointed first to the close relations between textiles and biology, and then to their relations with the plastics industry, and to the part played in recent developments by such a tool as X-rays. The reasoned, scientific development of regenerated protein fibres is a direct consequence of X-ray studies carried out in a university. Again, such synthetic fibres are really supplementary to natural fibres and not just substitutes; they increase textile potentialities, and at the present rate of progress and in a sane economic world there is no knowing to what heights science may lead the textile industries. Dr. Astbury strikingly emphasized the indivisibility of science, pointing out that the study of wool and the study of muscle are not easily separated, and Prof. J. D. Bernal, in summing up, said that science and industry are two aspects of one principle—we must find the proper relation between the organization of science and industry, always remembering that it should be a two-way traffic. Whereas in the older industries the process may be mainly one of infiltration of science, in the newer industries the discussions indicated that the most conspicuous feature might be the stimulation of science by industry.

Opening the afternoon session on "Fundamental Research in Relation to Industry", Lord McGowan, who presided, suggested that we should consider as fundamental any research which is primarily directed to increasing our understanding of the causes of phenomena and of the principles and generalizations which make up the so-called 'laws' of Nature. Com-

enting on the development of our knowledge of ant design, he suggested that what is commonly rmed the 'safety factor' to allow a sufficient argin of size would be more aptly described as e 'ignorance factor'. Research in the chemical dustry can be described as of four types that rected to maintain and improve the quality products and economical working, chemical igneering research, that into problems of industries rved by chemical industry, such as agriculture, and eculative research, such as that in the high-pressure old, of which polythene has been the outcome. On us Lord McGowan commented that it is difficult o ensure the continuous prosecution of fundamental earch in a laboratory where interesting and exciting ndustrial developments are taking place. The bulk e the fundamental research should be carried on in iversity laboratories, though some would be rried out in Government laboratories, and Lord McGowan said that Imperial Chemical Industries td has decided to establish a special laboratory for ndamental research, administratively and geo-aphically separated from works laboratories.

Lord McGowan was followed by a trio of brilliant apers which should effectively dispose of the view ace entertained at British Association meetings that gineers have the monopoly of lucid exposition and ear delivery. Prof P M S Blackett, dealing with hysics, urged that research should be directed to heapening the production of good articles and not mply towards increasing the number of fancy rticles, and referred to unfavourable factors in our onomic system which require attention. He urged hat close relation between pure and applied research s essential and condemned the snobbery which ometimes hinders such contacts. More generous pport for fundamental research is required, and he eaded for more corporate action by scientific bodies uch as the Royal Society and professional bodies in eviewing the country's scientific resources, their isposition, and the planning of policy. To do this. aff will be essential and a watch should be kept over e effect of chance discoveries. Our main task is to asure, first, the application of science in raising the andard of living, the prosecution of science as a ultural or intellectual interest will follow. If Prof lackett's observations were general, Prof E C oddds kept strictly within the field of biochemistry, sing the discoveries of penicillin, of insulin and of e synthetic oestrogens to illustrate the immense ontentialities of biochemistry for human life, espec- ily in the Middle and Far East, where the repercus- ons on population problems may be profound. ll these discoveries arose in academic laboratories, id the first need is to encourage fundamental research id provide the investigator with every facility to periment merely for the sake of experimenting.

Dr C D Darlington, in discussing the unity and ower of biology, gave a no less fascinating picture e implications of biology in the field of plant and umal breeding, of the control of diseases of crops, id of such human scourges as cancer. The teaching f biology, he urged, is thirty years out of date, and at will delay the fruition of the unity and power hich he described. From what we know of different odes of activity of proteins, common fundamental inciples are emerging, which will provide an intel- ctual and a material power which will make life ry different for us all. Dr D P. Riley, who fol- wed, in spite of the fact, which he duly noted, that e speakers at the Conference included five eminent

in X-ray work, made the mistake of attempting to cover too wide a field in the time, and his enumeration of the many fields of application of X-rays in science and industry was too ill prepared to leave him the opportunity to develop adequately his remarks about the training courses in X-ray work at Cambridge to ameliorate the shortage of X-ray workers, or on the importance of freedom of publication of scientific research both as a stimulus to research and an incentive to the investigator.

The session on the morning of January 13, over which Sir John Greenly presided, was devoted to industrial research and development, and brought some more impressive evidence of British technical achievements and the impact not only of science on industry, but also of one industry on another. Sir John Greenly, confining himself to general observations, reaffirmed his own conviction that science has contributed and will continue to contribute immeasurably to successful industrial enterprise. Quoting from Marcus Aurelius, he urged that to investigate systematically and truly all that came under our observation is exactly what we expect of science in its application to industry. Besides the contribution of new ideas and prospects from fundamental research leading to new inventions, there is, scarcely less important, the continuous help given to the normal conduct of a business by indicating improved methods of production and suggesting the use of new materials. He cited welding as a particularly good illustration of the way in which science has helped to make an industry more efficient and, by providing a new and better technique, assisted in solving the problems of export and full employment. Finally, he stressed the importance of full co-operation and team-work on the part of all concerned, and above all of giving the scientific worker the fullest opportunities in order to enable him to continue to be the pathfinder of industry.

Dr C Sykes followed with a review of the general field of metallurgy, in which he pointed out that there is no hard and fast line between research and development. Dr Sykes emphasized the cost of development work and the dependence of the rate of development on the degree of confidence it establishes between suppliers and users. With regard to post-war development, he foresees four types of problems and needs: the proper allocation of the available technical personnel, the adequate development of schools for research at the universities, the encouragement of enterprise, in which connexion he welcomed the Chancellor of the Exchequer's recent concessions with regard to obsolescence, and the furthering of collaboration between industries. It was natural enough that Dr S G Hooker's account of the development of the Merlin engine and of what those developments have meant in extending the carrying power, climbing power, speed and general performance of aircraft in service with the Royal Air Force should have attracted most attention at this session of the Conference. His paper provided a striking illustration of technical and scientific development stimulated by the War, but Mr W C Devereux's paper on research and development applied to light alloys was more instructive with regard to the main purpose of the session. Mr Devereux gave a most striking picture of the way in which scientific advances, such as Dr W Hume-Rothery's brilliant work in metallurgical physics at Oxford, and new techniques such as X-ray diffraction, are opening up new possibilities in this field. Like Lord McGowan, he referred to the twin function of

the universities in advancing knowledge of science and in providing industry with men qualified to interpret this new knowledge. Industry also must play its part by making scientific posts sufficiently attractive to ensure a steady stream of the right type of men through the universities. He also suggested that the universities might take stock of the position arising out of the demand for scientific men fully qualified for the higher posts in research management and administration, for which there is at present an undoubted lack of suitable men. Mr Devereux commented on the way in which the volume of routine testing is increased by lack of fundamental knowledge of the properties of materials, and describing the development work at Light Alloys Ltd, said that in addition to a Process Development Department dealing with the development of new processes and improvement of old processes within the scope of their normal activities, there is an Engineering Development Department concerned with the development of new ideas and the engineering uses of the products manufactured. Dr J C Swallow, in the course of a brilliant short paper on plastics, contrived to give not only a lucid exposition of the structural relations of the synthetic organic thermoplastics, such as polymethyl methacrylate, polyvinyl chloride, nylon, polythene, polyisobutylene, but also to demonstrate the variations in their properties, with a deftness and nonchalance that a conjurer might have envied. This he followed up by indicating clearly and concisely what is involved in the industrial development of such products: the close co-operation of the organic and the physical chemist, the physicist, the chemical engineer and the engineer, and the importance of the development of knowledge of the fundamental principles of plastic flow, and the perfection of methods of measurement both in regard to the application and the manufacture of plastics, though Dr Swallow observed that in such industrial developments there is art as well as science. Above all, it is important to have available as many clarifying principles as science can provide, relating properties to structure, in order to be able to select and concentrate on the development of those plastics likely to be the most useful and to prevent dissipation of research effort.

The story which Mr A L Bacharach had to tell of the synthetic vitamin industry was no less fascinating, and if the session seemed to come to a lame conclusion and the red lights came on insistently for the first time, it was rather because of Mr Bacharach's failure to prepare his material adequately with reference to the time factor, so that discussion of the questions to which his account of the development and possibilities of this new industry, not merely for therapeutics, but also in nutrition and the food industries generally, naturally led, was prematurely terminated. Mr Bacharach pointed out that this new branch of chemical industry is less than twenty years old, and that not all the products are in the strict sense synthetic, they may be extracted from natural sources or degraded from natural compounds. All the important discoveries on which the industry is based were made in university or institutional laboratories, and even the isolation, purification or determination of constitution was effected in such laboratories and not in industrial laboratories. The type of problem is one calling almost solely for the co-operation of the organic chemist and the chemical engineer. Finally, Mr Bacharach emphasized the identity of the natural and synthetic vitamins, and

the widely varying scale on which the various processes of manufacture are carried on.

The final session of the Conference was devoted to "The Future: What Science might Accomplish" and in presiding over this session, Lord Woolton spoke of the lessons for peace of war-time triumphs. Rejecting alike the totalitarian approach with its abandonment of freedom and the *laissez-faire* doctrine of trusting to chance, Lord Woolton believes that public opinion will demand that in certain spheres the Government should exercise a greater influence than it did before the War, and that if we use the knowledge we have gained of necessity in war, we have much material on which to reconstruct a healthier and happier society in the future. Within a few weeks of his taking office as Minister of Food in April 1940, we were faced with a 50 per cent drop in our food imports, and were saved from starvation by the application of scientific knowledge to the problem of securing the right foods, not to satisfy our appetites, but to meet nutritional needs. Advances which scientific research has made in handling food, such as dehydration, both save shipping space and preserved food, while in agriculture scientific research has made it possible to increase yields beyond all expectation. Steps taken to increase the consumption of milk, to encourage the eating of selected vegetables, to provide certain classes with orange juice, cod-liver oil, vitamins and calcium tablets to develop communal feeding and meals in factories, and to expand the scheme for meals in schools, should form a permanent part of our health programme. Lord Woolton urged the British Association to continue its educational work in the field of nutrition, and said that in the fields of housing, in trade and industry, and the effective use of manpower, we should also seek to turn to account the lessons and experience of the War. He fully agreed that post-war reconstruction should begin with housing that involves determining the standard of housing that will enable people to live healthy lives and then the application of scientific knowledge to the design and construction of houses.

For the best uses to be made of our scientific resources, there must be closer contact between scientific workers in industry and those in the universities, more integration between research and development, and more pooling of information about new developments. The State and industry must see that scientific research, whether medical, agricultural, industrial or fundamental, is adequately endowed.

Mr E Carter followed with a paper on science and housing, in which he pointed out that the comparatively few advanced modern houses built between the Wars must be regarded as laboratory models rather than parts of a housing achievement. He urged that housing should be considered as primarily a social problem, taking account of potentialities rather than actualities. The contribution of science, he suggested, has three aspects: definition of the problem, which involves a large extension of a scientific survey of the attitudes of people to their domestic life and equipment, of the dynamics of family living, and of the physical factors that govern house plan and equipment, sizes and shapes. Secondly, we have to provide solutions, bring all our techniques, material and equipment to a high pitch of efficiency and to co-ordinate them into integrated designs for dwelling and communities. Finally, there is the operation stage—the business of economics, scientific manage-

ment, production and job supervision. Scientific workers, said Mr Carter, are not happy working to make low standards tolerable, nor will they for long be content to design high standards which cannot be translated into the real life of the mass of the people.

No brief summary could do justice to this highly suggestive paper or to those which followed from Sir Joseph Barcroft on food and from Prof J M Mackintosh on health. Sir Joseph Barcroft, pointing out how little we know of nutrition in regard to the brain, gave a glimpse of the possibilities if the nourishment of our central nervous system could be placed on an ascertained basis. Predicting a great change within ten years with regard to the certainty of our knowledge of the relation of food to man, Sir Joseph indicated some of the problems, such as those of labour, requiring investigation, and the decisions which will have to be taken in regard to milk policy, meat policy and the like. He also referred to the shortage of research workers, many more will be required to prosecute on any adequate scale the investigations on the nutritional demands of muscular exercise, mental work and maternal potentiality which lead to rational or functional nutrition.

In a brilliant survey of what preventive medicine might accomplish, Prof J M Mackintosh suggested that surgical science is still only in the clumsy experimental phase of its childhood, and that plastic surgery has only just begun to take shape. Recent advances in plastic surgery are not merely refinements in technique, but rather the progressive application of new biological knowledge, recent work on the lungs, the nerves and the blood vessels has opened up great highways for the march of science. Surgery has secured a powerful ally in biochemistry, but the mechanical expert is badly needed in the surgical repair shop, and the chemist must be called in to help in the search for non-irritant materials which can be used in surgical architecture. In preventive medicine, Prof Mackintosh said we must recognize the environmental factors, represented by sanitary science, housing, town planning and the like, and the personal factors, with the family and social background. He stressed the importance of water supply and also atmospheric pollution. Smoke prevention is one of the immediate tasks of sanitary science. On the personal side, preventive medicine stands at the door of opportunity, and the brilliant discoveries of bacteriology and biochemistry have yet to be applied. We have still to organize concerted attacks on such problems as tuberculosis, and we should also be deeply concerned with the positive aspects of prevention, there is need, for example, for a new spirit of health organization in industry, especially for the benefit of the smaller occupations and the widely distributed activities of transport and service. Finally, Prof Mackintosh referred to the possibilities in the field of international health, and urged the importance of co-operation between the medical and other technical experts, in which each should be ready to subordinate his ideal to the common purpose.

Sir Lawrence Bragg, speaking on the place of science in industry, said that although the British have a fine record in pure science and seem to breed the right type of man for breaking new ground, initiating new branches of science and solving old problems in an unexpectedly simple way, there are three bottlenecks which are restricting the vitalizing function of science in industrial and national affairs. First, the fact that

science is not yet a recognized part of a good general education, especially the higher education of those from whom the leaders of the future are likely to emerge. Secondly, he finds a very general reluctance of the most brilliant of young scientific workers to enter industry, and thirdly, the disposition of young people with a good deal of idealism to desire work directed mainly by considerations of social service. Sir Lawrence Bragg thinks that the War has indicated means of overcoming these difficulties, and finally he pointed out that when we ask what science might accomplish we should also ask what do we wish it to accomplish. The higher achievements of the human spirit are founded on man's command over Nature, and the wider and stronger science can make that foundation the higher the edifice which can be built upon it.

In summing up the Conference, Sir Harold Hartley commented that he had not found, as a teacher of chemists, the difficulty to which Sir Lawrence Bragg referred. Emphasizing a number of points which came out, such as the stimulus which science and industry mutually derive from one another, the impact of one industry on another, he referred to the general agreement on the need for greatly increased support for research, and particularly for more endowment by the State, and for making a scientific career really attractive and giving the scientific worker full encouragement and freedom to work in the way in which he can best develop his powers. There is agreement that the shortage of man-power makes it imperative to see that trained intelligence is directed into the right channels, and if the Conference contributes to a general realization of what has been done and how much still remains, it has also clearly indicated something of what is possible if we harness the brain power of the scientific worker to the improvement of the prosperity and welfare of the community.

CROP PRODUCTION IN NUTRIENT SOLUTIONS

By SIR JOHN RUSSELL, F.R.S

SEVEN years ago Prof W F Gericke, of the University of California, published an article in *Science* under the title "Hydroponics—Crop Production in Liquid Culture Media", and he followed this up in 1940 by a book, "Complete Guide to Soil-less Gardening". The idea attracted certain people very strongly, and before long it was necessary for some of the staff of the University to point out that some at least of the claims that were being put forward lacked good evidence. The method was critically but impartially investigated in Great Britain by Prof R H Stoughton, of the University of Reading, Dr G H Bewley, of the Cheshunt Research Station, and Messrs W. G. Templeman and S J Watson, of Jealotts Hill, and it is now possible to obtain a much more complete view than could be done before.

In principle, it is the water-culture method familiar to generations of botanists: plants are grown in nutrient solutions and not in soil. But the scale is different. Instead of individual plants each in its own bottle, the plants are grown in considerable number in specially constructed troughs holding the culture solution, the seed or seedling being supported on a specially prepared bed of vegetable litter.

Prof Gericke has recently pointed out an important difference between the culture medium and the soil which may open up some interesting scientific problems. Hitherto, he says, agricultural chemists have devoted much attention to the relations of the soil and plant growth. The soil was studied as the anchorage for the plant, and the different types of soil were known to induce different types of root development. There is, in fact, some kind of relationship between soil type and the architecture of the root. Further, the soil is the reservoir for water for the plant. It will not give up all that it holds, and much important work has been done on the partition of water between soil and plant. Finally, the soil plays an important part in the mineral nutrition of the plant, holding the phosphates and potash in various degrees of intensity, again there is something like a partition.

Prof Gericke points out that all these relationships disappear in water culture. What is wanted now, he says, is a study of the plant in relation to the culture solution, and this will obviously lead to very different results from those obtained in connexion with soil.

For a given plant, the root system is much less varied in water culture than it is in soil. Roots in water culture are neither as thick or as thin, nor as long or as short, as they can be in different soil types, nor do they live as long. On the other hand, many more new roots arise from the root crown in water culture than in soil. The effect on total growth varies with the plant. Some kinds of plants make better growth than in soil, others less. This narrowing of the range of variation of the roots leads to a further result: the mineral compositions of different species when grown together in the same nutrient solutions are more alike than when they are grown together in the same soil.

On the other hand, a somewhat wide variation in the composition of the nutrient solution is permissible, there is no optimum ratio of the nutrient elements, nor an optimum pH value. Certain elements, however, are needed in larger amounts than others, and some are toxic if present in excess.

The subject of hydroponics, however, was not put forward to encourage the study of the relations of plant roots to water, it was to be an alternative to soil culture. Experiments in Great Britain have not given results so promising as some of those reported from California. As mentioned above, they have been made at three stations: the University of Reading, Jealotts Hill and Cheshunt. All failed to obtain the huge crops of tomatoes—200 tons per acre—claimed in California, and in fact they obtained no better results than in soil. Prof Stoughton attributes this to the low light intensity prevailing in Britain and to the difficulty of ensuring adequate aeration for the roots.

As an alternative, Prof Stoughton prefers sand culture, in which the nutrient solution is periodically pumped up into the vessel containing the plants and then allowed to return to the supply tank; this ensures adequate aeration of the roots and, for certain flowers at any rate, it has given better results than the water-culture method*. The best plants are usually no better than the best in soil, but there is greater uniformity, and in consequence better average yields. Certain difficult plants also appear to grow more freely in sand culture than in soil.

Dr Bewley's experience has been on similar lines

He did not get better crops of tomatoes in sand culture than in soil, but of course his standards are high and he is no stranger to a crop of 80 tons per acre growing on steamed soil. But he also finds that certain flowers do better in sand culture than in soil. Carnations came earlier and in greater quantity, though it did not appear that their quality was as good as in soil.

Prof Stoughton arranged for chemical analyses of some of the crops grown in sand culture to see if there was any evidence of inferior nutritional value as compared with crops grown in soil. But none could be found. As against this, Prof Gericke states that the protein content of plants grown in nutrient solutions does not rise so high as it can do in soil.

Thus it appears that the growth of plants in nutrient solutions opens up a number of scientific problems especially those related to root growth and the phenomena of flowering, and it opens up also many practical problems which when the War ends will no doubt be seriously studied. But it can be said at once that there is no evidence that any significant contributions to war-time food supply of Britain can be expected from the method.

THE TAXONOMY OF BRITISH BRYOPHYTES AS A FIELD FOR RESEARCH

By DR. P. W. RICHARDS
Botany School, Cambridge

THE note in *Nature*¹ on the recently published history of the British Bryological Society ends with these words: "The taxonomy of mosses and liverworts is now largely established, but many bryological matters still require elucidation. Perhaps the post-war period will provide opportunities for detailed ecological studies—the relation of a moss or liverwort to its substrate, its reactions with other plants, and particularly of its unique physiology, which allows a special phenology of reproduction not possessed by any other kind of plant." With the second part of this statement every student of the bryophytes will be in warm agreement, but the first part, with its implication that taxonomically the bryophytes are an exhausted field, perhaps conveys a misleading impression. It may therefore be worth while to survey briefly the present position of bryophyte taxonomy so far as it concerns the British Isles.

The systematic study of the mosses and liverworts has long been established in Britain. In the eighteenth and nineteenth centuries British botanists made very notable contributions to the taxonomic study of these groups. Since then, though workers on the bryophytes have, of course, been few compared with those concerned with other groups of plants, the British contribution to bryophyte taxonomy has still been large, the work of the late Symers MacVicar and W. E. Nicholson on the liverworts and of the late H. N. Dixon on the mosses being especially important. British bryologists are fortunate in having in MacVicar's "Student's Handbook of British Hepatics"² and Dixon's "Student's Handbook of British Mosses"³ two excellent handbooks in which the known species and varieties are admirably described and figured. Such works as these, however, can never be final or impossible to improve, they should mark the begin-

* For details, see Stoughton, R. H., *J. Roy. Hort. Soc.* 68, 17 (1941).

ning rather than the end of a period of development.

Since the publication of the last editions of Dixon's and MacVicar's "Handbooks" a number of important additions have been made to the British bryophyte flora. The chief additions among the liverworts are *Cephalozia affinis* Lindb (Jones¹), *Scapania apiculata* Spruce var *Jonesii* Nicholson (Nicholson²) and *Telaranea nematodes* (Gottsche) Howe (Buch³, Richards⁷), a member of a monotypic genus previously known only from tropical America and Africa, but afterwards reported from the Azores and western Pyrenees. Further, British workers seem to have overlooked the fact that *Scapania parvifolia* Warnst and *S. paludicola* Loeske and K. Mull have been recorded as British by Buch⁸. Among the mosses the Mediterranean *Cheilothea* (*Ceratodon*) *chloropus* (Brid.) Lindb (Binstead⁹) and the long dubiously British *Cnephodorus riparius* (Host.) Arnott (Nicholson¹⁰) have been added to our flora, while recently Heslop-Harrison and Cooke¹¹ have found in the Hebrides *Andreaea Hartmanni* Thed. and *A. Blythii* Schp., both previously known only from Scandinavia, as well as *Longstroemia longipes* Sommerf. and *Currphyllum* (*Eurhynchium*) *Boscii* (Schwaeg.) Grout, the last-named being new to Europe. These discoveries show that among species generally recognized in other countries additions to the British flora are still to be expected.

The main need, however, is not so much for the intensive search for additional species as for a critical re-examination of those long known to occur, especially of those in polymorphic groups. It is generally recognized that both the mosses and liverworts abound in highly plastic species. Though some bryophytes, for example, *Breutelia chrysocoma* (Dicks.) Lindb., *Bazzania trilobata* (L.) Gray, seem to be extremely stable and vary remarkably little, even under the most diverse environmental conditions, many species are notoriously variable, the ubiquitous *Hypnum cupressiforme* Hedw. being an outstanding example. Observations in the field at once suggest that much, though not all, of this variation is due to the direct modifying effect of the environment, by carefully noting how far different variants can be found growing side by side in the same environment, and how far they always occur in obviously distinct habitats, something can be done towards determining to what extent the variation is phenotypic and to what extent genotypic. It is clear, however, that the systematics of these polymorphic species can only be placed on a firm foundation if they are studied experimentally under controlled conditions.

In Great Britain, as yet, practically nothing has been done on these lines, but the work of H. Buch on the liverworts of Finland shows how profitable such researches are likely to be. Buch's methods¹² rest on the simple postulates that, (a) genotypically similar types may appear phenotypically different when grown in different environments, (b) genotypically different types appear different when grown in the same environment. Wild material of 'critical' species is transplanted either from one natural habitat to another, or from different natural habitats to an as far as possible uniform 'standard' environment—Buch's 'standard' environment consisted of a peat substratum in a wooden box with a loosely fitting glass lid kept in a living-room which was heated during the winter so that neither humidity nor temperature fluctuated very violently. Using these simple methods, Buch obtained results of great interest and significance for taxonomy. His work¹³ on

the *Lophozia ventricosa* group of leafy liverworts may be used as an illustration.

In MacVicar's "Handbook" eight 'species' in this group are recognized: (1) *L. ventricosa* (Dicks.) Dum., (2) *L. porphyroleuca* (Nees) Schiffn., (3) *L. guttulata* (Lindb. & Arn.) Evans, (4) *L. Wenzelii* (Nees) Steph., (5) *L. confertifolia* Schiffn., (6) *L. alpestris* (Schleich.) Evans, (7) *L. longidens* (Lindb.) Macoun, (8) *L. longiflora* (Nees) Schiffn. Buch was able to show that of these (1), (2), (4), and (6) were well-characterized species which remained obviously distinct when grown under the same conditions, *L. guttulata* proved to be a modification (phenotypic form) of *L. porphyroleuca* produced by conditions of strong illumination and evaporation, and *L. confertifolia* was found to be a parallel modification of *L. Wenzelii*. The status of *L. longiflora* remained undecided. During the investigations the existence of two new species in the group, neither of which has yet been detected in Britain, was disclosed, one of these, *L. silvicola* Buch, is recognized mainly by the highly characteristic appearance of the oil-bodies in the cells, a character which is only observable in living material, the species being impossible to separate from *L. ventricosa* on herbarium material alone. The morphological differences between *L. Wenzelii* and *L. ventricosa*, and between *L. porphyroleuca* and *L. ventricosa* respectively, are comparatively small, and as both *L. Wenzelii* and *L. porphyroleuca* have more specialized habitat preferences (bare rock and rotten wood respectively) than *L. ventricosa*, Buch suggests that they are comparable with Turesson's ecotypes among the higher plants.

In other genera very similar results were obtained. In the genus *Scapania*⁸ culture experiments showed that *S. undulata* (L.) Dum., *S. dentata* Dum. and *S. intermedia* (Husn.) Pears were all modifications of one and the same species which could readily be transformed from one into another. The distinctness of *S. undulata* and *S. dentata* as 'good' species had previously been generally accepted. In the genus *Calypogeia* Buch¹⁴ found that what had hitherto been regarded as a mere variety of *C. Neesiana* (Carest. & Massal.) K. Mull proved to be a thoroughly distinct species when grown side by side with normal *C. Neesiana* under cultural conditions.

Since the modifications of different species under diverse environmental conditions are strikingly parallel, Buch suggests that a uniform system of nomenclature should be applied to the modifications of all plastic species of leafy liverworts. For example, modifications with strongly thickened cell walls which occur under conditions of high evaporation should be called mod. (=modificatio) *pachyderma*, while those with reddish or otherwise pigmented cell walls (found in strongly illuminated habitats) should be called mod. *colorata*. A modification combining more than one such character could be referred to by a combined name, for example mod. *pachyderma-denticulata-colorata*. Whether this system of nomenclature is feasible can only be shown by experience, but in any event the suggestion is an interesting one as showing the widespread occurrence of parallel phenotypic variations in this group of plants.

It would be of great value to extend Buch's experimental methods to all our polymorphic groups of mosses and liverworts. So far almost nothing of the kind has been attempted for the mosses, though unpublished experiments by the author have shown that the well-known sand-dune moss *Tortula ruraliformis* (Besch.) Dix. which is variously regarded as a

variety or a 'sub-species' of the common inland species *T. ruralis* Hedw., retains its distinctive characters when cultivated side by side with *T. ruralis* under experimental conditions.

The group of mosses to which the application of this technique is most urgently necessary is the genus *Sphagnum*, a genus which, as is well known, has been a fruitful field for the species 'splitter'. Anyone who is familiar with the genus in the field realizes that it is a particularly plastic one in which phenotypic variation is readily induced by differences in water-level, in exposure to light, etc. Warnstorf, who monographed the genus for Engler's 'Pflanzenreich', described a vast number of species of which a large proportion are almost certainly merely modifications. Following Warnstorf's delimitation of the species, no less than 47 sphagna have been recognized in Britain, each with a multitude of varieties and forms. Le Roy Andrews¹⁵, on the other hand, on the basis of careful herbarium studies alone, would reduce our number to about twenty-six. In the particularly difficult group of the *Sphagnum subsecunda*, Åberg¹⁶, after a very careful study (though without using experimental methods), recognizes only three European species as compared with the eighteen recognized by Warnstorf. In one locality in Sweden he observed a 'natural experiment' in which owing to the falling of the water-level in a lake an originally uniform carpet of *S. subsecundum* Nees var. *innundatum* (Russ.) emend. had become transformed into two modifications, one growing in the water and one above it, these modifications, according to Åberg, would certainly have been regarded by Warnstorf as distinct species.

The introduction of experimental methods is not the only improvement desirable in our taxonomic technique. Great advances can be made by making methods of description more precise and refined. Buch, in his admirable monograph⁸ of the *Scapania* species of northern Europe, has shown how much can be done in this direction. Bryophytes are plants in which many taxonomically useful characters (cell size, ratio of length to breadth of leaves, seta length, etc.) are readily measurable and may be treated statistically. Several workers have already successfully demonstrated the value of statistical methods in bryophyte taxonomy (for example, Malta¹⁷, Walther¹⁸, Wynne¹⁹). As with the higher plants, a combination of cytogenetic with taxonomic methods is certain to be fruitful. Evans²⁰ showed that all forms of the genus *Dumortiera* fall into one of two morphological groups, afterwards it was shown²¹ that in one group the haploid chromosome number was 9, while in the other it was 18. Burrell²² has suggested that *Orthodontium gracile* (Wils.) Schwaeg. var. *heterocarpum* Watson, which is rapidly spreading in the British Isles, is a polyploid of recent origin.

Up to now this article has been concerned only with the species and minor taxonomic units, but advances can also be looked for in 'major' taxonomy. With changing views on the phylogeny of the liverworts (cf. Harris²³) and a general recognition that the simpler types are reduced rather than primitive, a need for a revision of the classification has been felt. Classifications in harmony with the new views have been put forward by Verdoorn²⁴ and by Evans²⁵. A check-list of the liverworts of Europe and North America arranged according to Evans' classification has been published by Buch, Evans and Verdoorn²⁶, this list embodies Buch's²⁷ useful subdivision and re-classification of the obviously artificial genera *Lophozia* and *Sphenobolus*.

For the mosses the scheme of classification proposed by Fleischer and adopted with various modifications in the second edition of Brotherus' two volumes on the Andreeales and Bryales in Engler's 'Pflanzenfamilien' has obtained general acceptance among Continental bryologists. In Britain the older classification adopted in Dixon's 'Handbook' is still in vogue, but it seems high time that Fleischer's system came into use in Great Britain also.

From this short survey it will be clear that the taxonomy of the bryophytes offers abundant problems for research. There is still much to be done both for the amateur and the professional worker, especially if the words of that stimulating bryological critic, L. Loeske²⁸, are borne in mind, 'Es gibt für die Systematiker keine höhere Forderung als die, auch zugleich Biologe zu sein'. In the British Isles we have an exceptionally rich and varied bryophyte flora. If the great opportunities that lie open to us are not to be lost, more research on bryological taxonomy is required. It is at least to be hoped that after the War one of our great national herbaria will find it possible to appoint a member of its staff whose whole time is devoted to this much-neglected group of plants.

¹ *Nature*, 153, 768 (1944).

² MacVicar S. M., 'Student's Handbook of British Hepatics', Ed 2 (Eastbourne, 1926).

³ Dixon, H. N., 'Student's Handbook of British Mosses', Ed 3 (Eastbourne, 1924).

⁴ Jones, D. A., 'Cephalozia affinis Lindb. in Ireland', *Rep. Brit. Bryol. Soc.*, 3, 294 (1935).

⁵ Nicholson, W. E., 'A New *Scapania* from Ireland', *J. Bot. Lond.*, 78, 15 (1938).

⁶ Buch, H., 'Telaranea nematodes aus Irland', *Ann. Bryol.*, 9, 32 (1938).

⁷ Richards, P. W., 'Telaranea, a Genus of Hepatics, New to Europe, Discovered in Ireland', *Proc. Linn. Soc. Lond.* 150th sess., 116 (1938).

⁸ Buch, H., 'Die Scapanien Nordeuropas und Sibiriens', *Soc. Sci. Fennica, Comment. Biol.*, 3, 1 (1928).

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¹¹ Heslop-Harrison, J. W., and Cooke, R. B., 'Andreea Hartmanni Thed. and A. Blyttii Schump., Two Mosses New to the British Isles, from the Hebrides, with Remarks on other Hebridean Species of the Genus', *J. Bot. Lond.*, 80, 35 (1942).

¹² Buch, H., 'Eine neue moosystematische Methodik nebst einigen ihrer Resultate und ein neues Nomenklaturesystem', Rept. 18 Scand. Naturhist. Congr. Copenhagen, 26-31 Aug. 1928.

¹³ Buch, H., 'Experimentell-systematische Untersuchungen über die Lophozia Ventricosa-Gruppe', *Ann. Bryol.*, 6, 7 (1933).

¹⁴ Thériot, I., Dixon, H. N., and Buch, H., 'Bryophyta nova', *Ann. Bryol.*, 7, 157 (1934).

¹⁵ Le Roy Andrews, A., 'Notes on the Warnstorf Sphagnum herbarium—I', *Ann. Bryol.*, 9, 3 (1936).

¹⁶ Åberg, G., 'Untersuchungen über die Sphagnum-Arten der Gruppe Subsecunda in Europa, etc.', *Ark. Bot.*, 29, 1 (1937).

¹⁷ Malta, N., 'Die Gattung Zygodon Hook. et Tayl.', *Latvijas Univ. Bot. Dzirva Darbi*, 1.

¹⁸ Walther, K., 'Untersuchungen über die Variabilität innerhalb des Formenkreises von Polytrichum juniperinum', *Ann. Bryol.*, 7, 121 (1934).

¹⁹ Wynne, I. E., 'Studies on Drepanocladus—I', *Bull. Torrey Bot. Cl.*, 71, 207 (1944).

²⁰ Evans, A. W., 'A Taxonomic Study of Dumortiera', *Bull. Torrey Bot. Cl.*, 48, 167 (1919).

²¹ Lorbeer, J., in Verdoorn, F., 'Hepaticae selectae et criticae, series III et IV (1932)', *Ann. Bryol.*, 5, 125 (1932), 142.

²² Burrell, W. H., 'A Field Study of Orthodontium gracile (Wilson) Schwaegrichen and its Variety heterocarpum Watson', *Naturalist*, 295 (1940).

²³ Harris, T. M., 'The British Rhaetic Flora' (London, 1938).

²⁴ Verdoorn, F., 'Classification of Hepatics' in 'Manual of Bryology' (The Hague, 1932).

²⁵ Evans, A. W., 'The Classification of the Hepaticae', *Bot. Rev.*, 5, 49 (1939).

²⁶ Buch, H., Evans, A. W., and Verdoorn, F., 'A Preliminary Check List of the Hepaticae of Europe and America (North of Mexico)', *Ann. Bryol.*, 10, 3 (1938).

²⁷ Buch, H., 'Vorarbeiten zu einer Lebermoosflora Fennoscandias I. Ein Versuch zur Aufteilung der Gattungen Lophozia Dum. und Sphenobolus Steph.', *Mem. Soc. pro Fauna et Fl. Fenn.*, 8, 282 (1933).

²⁸ Loeske, L., 'Bemerkungen zur Systematik der Laubmoose', *Ann. Bryol.*, 8, 131 (1935), 148.

OBITUARIES

Dr. E. L. G. Clegg

THE hand of death has fallen heavily on the Geological Survey of India during the past few years, and we have lost in turn, and at a comparatively young age, Cotter (1941), Pilgrim (1943), and Christie (1944), all retired from the Department. Now we have to lament the death of a serving officer, Dr. Edward Leslie Gilbert Clegg, who passed away on September 8, 1944, some days after an operation in the General Hospital, Calcutta.

At the time of his death Clegg was director of the Geological Survey, having succeeded Sir Cyril Fox recently as July 1943. For the purpose of helping the great industrial expansion that is now seen to be necessary if India is to rise to her proper status in the world, the Geological Survey of India is in process of expansion to a strength much greater than before the unfortunate and ill-judged retrenchment of 1931. As Clegg had, throughout his service, shown himself to be possessed of a large modicum of common sense and a flair for administration, he was essentially the man for the job of director, and his untimely death must be regarded as nothing less than a calamity both to his Department and to India.

Clegg was born on February 24, 1894, at Manchester. He was educated at the Central High School (1904-12) and Victoria University, Manchester (1912-15 and 1919-20). He served through the War of 1914-18 as an officer in the Northumberland Fusiliers and saw much active service in France and Italy. After the war he returned to Manchester, took the M.Sc. degree in geology, and was then (1920) appointed an assistant superintendent in the Geological Survey of India.

For his first field-season, Clegg was posted to myrtly in the Central Provinces, and after accompanying me for a time, he was given an independent piece of work on the Archæans of the Nagpur district except for water-supply inquiries, and charge of work in the Central Provinces and of sulphur operations in Baluchistan after his return from Burma. In 1942, this proved to be the only field-work Clegg did in India *strictu sensu*. For in his second field-season he was posted to Burma, where practically all his field work was done in two spells. Between these two spells Clegg was at headquarters in Calcutta, first as curator of the Geological Museum, and then as officer-in-charge of the Geological Survey Office. During this period he acted also as lecturer in geology at Presidency College and at the Bengal Engineering College, Sibpur. In addition he took a keen interest in the Mining and Geological Institute of India, acted as one of the joint honorary secretaries during 1927-30, and was vice-president in 1943. He became D.Sc. of Manchester in 1939.

In 1932 Clegg was promoted to the grade of superintendent, and placed in charge of the Burma Circle. On account of the approaching separation of Burma from India, it fell to my lot to devise a scheme by which geological survey work in Burma could be continued after separation, for Burma would then have no geologists, unless a portion of the Indian Geological Survey was to be cut off. The solution adopted was to form a new department, the Burma Geological Department, and staff it with officers seconded (on foreign service) from the Indian Survey for periods of five years at a time, until Burma could recruit her own geologists. Meanwhile the scientific

results of the work of the new Department were to be published in the *Records and Memoirs* of the Geological Survey of India, and this course has been followed up to date.

The separation took place on April 1, 1937, and Clegg became the first superintendent of the new Department, taking orders direct from the Government of Burma, instead of from the director of the Geological Survey of India. With the invasion of Burma by the Japanese, Clegg returned to India after making a valuable traverse through the Hukawng valley for the military (for a road through to India), emerging at Margherita in Assam in June 1942. It is perhaps not out of place to record that Mrs. Clegg, with Mr. and Mrs. Anil Dutt (also of the Indian Survey), travelling by a route since made famous by the 14th Army, escaped from Burma in March 1942 *via* the Kalewa-Kabaw valley and Tamu to Palel in Manipur, walking the whole way, with coolies to carry their few possessions and a servant to push or carry a bicycle. From Palel they continued by motor-bus through Imphal to Dimapur and thence by train to Calcutta.

While in charge in Burma, Clegg had occasion to visit most of the Burmese mineral deposits in order to advise the local government on their mining administration, and on the many problems that arise in the grant of mineral concessions. He also obtained an intimate knowledge of the Burmese oilfields while acting as resident geologist at Yenangyaung in 1935 and 1936. This experience enabled him to write a valuable account of the "Mineral Deposits of Burma", published by the Government of Burma (1940). He also contributed the articles on lead, silver, tin, wolfram, and zinc, to the last "Quinquennial Review of the Mineral Production of India", and finally, in 1944, a bulletin on tin and wolfram to the *Records of the Geological Survey of India*.

On account of his administrative duties, Clegg had less opportunity for systematic field survey work than would otherwise have been the case. Nevertheless he has two important memoirs to his credit. The earlier one, "The Geology of Parts of the Minbu and Thayetmyo Districts, Burma" (*Mem. Geol. Surv. Ind.*, 72, Pt. 2, 137, 1938), contains an account of his work in these districts, mainly during his earlier spell in Burma. In making use of the writings and maps of his predecessors and of contemporary workers in this and adjoining tracts, Clegg shows a capacity for digesting the work of others and of expounding the combined results with the impartiality of a balanced mind, qualities very useful for the director-to-be of a Geological Survey. Those who wish to follow the tangled story of the nomenclature of the Burma Tertiaries cannot do better than consult this memoir.

On his return to Burma as superintendent of the Circle in 1932, Clegg was set the task, with the assistance of Dr. Narayana Iyer, of making a detailed map of the Ruby Mines area of Mogok, which had already been commenced by Dr. Coggin Brown and Mr. A. K. Banerji, and for which new large-scale maps had been specially prepared by the Survey of India. In three field-seasons Clegg and Iyer completed this survey, but the results have not yet been published. Clegg was not satisfied that the marbles and gneisses of the Mogok tract were Archæan in age, as was generally supposed, consequently he seized every opportunity of making traverses in northern Burma (the defiles of the Irrawaddy, the Jade Mines District, Mongmit State) in a search for clues. This led to important results, with the discovery of a new foraminifer

(*Orbitolina burmanica* Sahn), regarded as of Upper Cretaceous age and found not only in the limestones and mudstones of both defiles of the Irrawaddy, but also in the limestones of the Jade Mines District, which in places are highly crystalline, with rubies and spinels. In consequence wide tracts of Upper Burma, both of sedimentary and volcanic rocks, are now regarded as Cretaceous in age, where rocks of this age were not previously suspected to occur. Clegg gives a full account in his second memoir "The Cretaceous and Associated Rocks of Burma" (*Mem Geol Sur Ind*, 71, Pt 1, 1, 1941). As the original inspiration for this work was derived from his study of the Mogok area, it is not surprising that Clegg makes a valiant attempt to show that the ruby-bearing limestones of Mogok are also of Cretaceous age. Unfortunately, in his traverse across Mongmit State in the north to the Mogok area in the south he was frustrated by a "gap of about three miles between the definitely shelly limestone rocks of the Cretaceous series and totally re-crystallised and homogeneous limestones of the Mogok series" (*loc cit*, p. 29). The gneissic and schistose rocks of the Mogok area are, however, as highly metamorphosed as those of the Eastern Ghats area of India, or of Ceylon, being uniformly of hypometamorphic grade, including, for example, khondalite (see *Rec Geol Sur Ind*, 68, 27). I have myself twice visited the Mogok tract, once with Dr. Coggin Brown, and once with Dr. Clegg, and I find it difficult to accept the view that in the main the Mogok tract is not an Archæan outlier of the Indian section of Gondwanaland. The Kamaing granite is, however, definitely intrusive in the Mogok series and may be of the same age as the granitic axis that forms the backbone of the Indo-Malayan Peninsula,

and is known to be post-Triassic in age and perhaps Upper Cretaceous. However, Clegg has disturbed the complacency of Archæan enthusiasts, and shows the Mogok gneiss, including the marbles, be eventually proved to be of much younger age, to Clegg we belong the credit of having created the doubt.

Besides being a good geologist and administrator Clegg was a good athlete. He made many friends and I personally look back with pleasure on time spent together in camp and at social gatherings, as well as to the splendid service he gave in all tasks both executive and administrative with which he was entrusted.

In 1926 Clegg married Helen Goode, a botanist graduate of Manchester, and he leaves two sons.

For some of the facts of this note I am indebted to an excellent obituary notice in the October 1944 number of *Science and Culture*, by Dr. H. Crookshank, who has succeeded Clegg as director of the Geological Survey of India. L. L. FERMOR

We regret to announce the following deaths

Dr. Guy D. Bengough, F.R.S., consultant to the Chemical Research Laboratory of the Department of Scientific and Industrial Research, on January 20, aged sixty-eight.

Sir Buckston Browne, honorary fellow of the Royal College of Surgeons, a generous benefactor of the British Association, on January 19, aged ninety-four.

Sir Henry Gauvain, past president of the Section of Electrotherapeutics and of the Diseases of Children of the Royal Society of Medicine, an authority on tuberculosis, on January 19, aged sixty-six.

NEWS and VIEWS

Prof. G. M. Bennett, Government Chemist

PROF. GEORGE MACDONALD BENNETT has been appointed to succeed the late Sir John Fox as Government Chemist. His appointment recalls those of two previous Government Chemists, Sir Edward Thorpe and Sir James Dobbie, each of whom was professor of chemistry before becoming Government Chemist.

Prof. Bennett received his earlier education at the East London (now, Queen Mary) College and proceeded to St. John's College, Cambridge, of which he later became a fellow after taking first classes in Parts I and II of the Natural Sciences Tripos. In 1917 he began original investigations in physical chemistry and on chemical problems of national importance at the time. After leaving Cambridge he was appointed successively demonstrator in chemistry at Guy's Hospital Medical School, lecturer in chemistry in the University of Sheffield and Firth professor of chemistry there in 1931. He was appointed to his present professorship in chemistry in the University of London at King's College in 1938. Prof. Bennett is also honorary secretary of the Chemical Society—an arduous office which brings the holder into contact with chemists generally and with chemical and organization problems of diverse types.

Prof. Bennett's record as an investigator is outstanding. He has made major contributions particularly to organic chemistry and to the stereo-

chemistry of sulphur compounds. He is a crystallographer, and his application of this science in his stereochemical investigations has been of great importance. As a physical chemist he has contributed to our knowledge of surface energy, valency angles and the mechanism of the formation of heterocyclic ring systems. It can be confidently predicted that Prof. Bennett's tenure of the unique office of Government Chemist will be distinguished from all points of view, he has a ripe experience not only of many branches of his subject but also a wide knowledge of men and affairs.

Chair of Chemical Pathology, University College Hospital Medical School. Prof. C. Rimington

DR. RIMINGTON, former scholar of Emmanuel College Cambridge, has been appointed to the chair of chemical pathology at University College Hospital Medical School. After a distinguished career in Sir Frederick Gowland Hopkins' laboratory at Cambridge, he organized the Biochemical Research Department of the Wool Industries Research Association at Leeds, and then for six years held a senior research fellowship of the Empire Marketing Board at the Onderstepoort Veterinary Research Laboratory in South Africa. In 1927 he was appointed to the staff of the National Institute for Medical Research, Hampstead.

Dr. Rimington's work has covered many fields of biochemistry, proteins, plant poisons and porphyrins,

to each of which he has made noteworthy contributions. In the field of protein chemistry he enlarged our knowledge of the phosphoric acid esters present in casein and of the serum glycoproteins, and latterly with his colleague, I W Rowlands, he has turned his attention with outstanding success to the important glycoprotein, gonadotrophin of pregnant mares' serum, a problem of great veterinary interest.

During his stay in South Africa, Dr Rimmington worked on the constituents of plants poisonous to stock and from this made an incursion with J I Quinn into the photosensitization of animals by phylloerythrin. With P J Fourie he discovered the first living cases of congenital porphyria in animals, and this has led to numerous contributions to the porphyrin field of pigment metabolism, on which he is an acknowledged authority. Without doubt Dr Rimmington will be received with welcome at University College Hospital Medical School, for his capacity for collaboration has been a valuable and invariable asset.

Geological Society Awards

THE Council of the Geological Society has made the following awards. Wollaston Medal to Prof O T Jones, emeritus professor of geology in the University of Cambridge, for outstanding contributions to knowledge concerning the stratigraphy of Lower Palaeozoic sedimentary rocks of Wales, Murchison Medal to Dr W Campbell Smith, keeper of minerals in the British Museum (Natural History), for his work on petrology and mineralogy, and his long service as secretary to the Society, Lyell Medal to Dr L F Spath, of the Geological Department of the British Museum (Natural History), who is the foremost expert on the Ammonoidea and on the classification and evolution of the Cephalopoda, Bigsby Medal to Prof. L R Wager, of the University of Durham, for his outstanding researches, mainly in petrology, on East Greenland, the Sikkim Himalaya and the north of England, Prestwich Medal to Mr A S Kennard, for his studies of Pleistocene faunas particularly of the non-marine mollusca, Wollaston Fund to Dr D R Grantham, for his work on the Geological Surveys of Tanganyika and British Guiana, especially in the field of mining geology, Murchison Fund to Dr W A Deer, for his researches on rock-forming minerals and petrology, especially of Scottish rocks, and his contribution to the description of the layered intrusion at Kangerdugssuak in Greenland, one moiety of the Lyell Fund to Mr A H Taitt, of the Anglo-Iranian Oil Company, Ltd, for his work on the exploration for oil in Great Britain, especially on the Nottinghamshire oilfield, another moiety of the Lyell Fund to Dr F B A Welch, of the Geological Survey of Great Britain, for his additions to our knowledge of the geology of south-west England, both above and below the Mesozoic unconformity, especially in relation to the complicated structures of the Mendips.

Display and Bower Building in Bower Birds

THE annual cycle of display and bower building by *Ptilinorhynchus violaceus* Vieill, the satin bowerbird, was discussed in *Nature*, 153, 685 (June 3, 1944), by A. J Marshall. He stated that this cycle is possibly due to the effect of increasing light and that stimuli from the bower act "through the anterior pituitary" upon the gonads. The selection of coloured decorations by the male matches the epigamic colours of

the female and may "serve the function of exciting himself by their resemblance to female colours". It is regrettable that Marshall omitted reference to published work on these lines when mentioning investigations carried out during 1939-41. In "A Contribution to the Biology of the Satin Bower-bird" (*Australian Zoologist*, 10, 95, 1941), E Nubling considerably antedates Marshall's conclusions and in some points differs from them. Nubling found that the bower building is not associated with increasing light, for during 1922-26 he found new bowers principally erected in May and June during decreasing light, and states that in such circumstances the whole proceeding of courtship and nidification fall into the period of decreasing light. Regarding the part played by the pituitary body, Nubling wrote (*loc cit.*, 119), "the role of the pituitary in connection with such sexual manifestations as posturing during display or ceremonial is thus apparently a factor of outstanding importance", and he quoted the opinion of F H A. Marshall (1929) that sexual posturing in birds exercises a stimulating influence upon the anterior lobe of the pituitary.

Nubling discussed the selection of colours very fully in 1941, and so long ago as 1924 had submitted conclusions which were published by Dr Casey A Wood (*Amer. J. Ophthalmol.*, 8, 120, 1925), as follows: "Nubling's preliminary experiments made with colored disks. I shall now report in his own words '1 Violet, indigo, blue. Any of these colours is collected by these birds, as well as any hue or tint thereof, without any discrimination'. 2. All the other colours collected correspond to those of the plumage, bill, legs, etc., of the immature male and the female, whose plumage is identical. On this I am almost positive, and many comparisons made, using Ridgway's Color Standards for the purpose, have borne out my contention". Wood points out that the irides of the female are of an even stronger blue than those of her mate. In 1941 Nubling wrote again (*loc cit.*, 117) that the "decorations are not collected for the sake of their brightness, but for their colours. . . they represent the insignia, so to speak, of his female mate. The presence at the bower of objects bearing her colours is then not so much for the purpose of attracting the female, but for his own stimulation, they act on him in the way of an aphrodisiac". Nubling compared the exciting colours with Ridgway's 1912 Colour Guide. It seems that the "lemon-yellow" mentioned by A J Marshall is so masked by grey that the resultant effect is erroneously described as lemon-yellow, it corresponds to Ridgway's "deep greyish olive", the colour of the upper surface of the female. This is produced by a structural effect, combined with superposed yellow lipochrome, the black plumage of the male giving a blue structural effect.

Health Problems in War-time

BRIGADIER-GENERAL J S SIMMONS (*Brit. Med. J.*, 572, Oct 28, 1944), speaking at the seventy-third annual convention of the American Health Association at New York on health problems during the past year or so in Italy, Sicily and north-west Europe, said that the public health programme is being carried out by a very small number of American and British medical officers and that it was necessary to rely upon local medical men. The greatest problems so far had been typhoid fever, dysentery, typhus fever, smallpox, malaria, venereal disease and scabies. In Italy and north-west Europe the incidence of typhoid

and paratyphoid fever rose after the military operations, but outbreaks had been limited to relatively few communities. The peak was reached in January 1944, when more than a million new cases were reported, but the outbreak was controlled so quickly that only 39 cases were reported during the last week of February 1944. Typhus had not yet been a problem in north-west Europe. Two outbreaks of smallpox had occurred in Italy, but none in north-west Europe. In February 1944, measures for the control of malaria were inaugurated in south and central Italy.

The United States War Department announced, on October 4, that tetanus had been virtually eliminated from the United States Armed Forces by compulsory immunization of all officers and men. No case had been reported among completely immunized troops, but a handful of cases had occurred when immunization had not been complete. Up to September 15, 1944, no cases had occurred in the United States Navy, which also requires compulsory immunization. Brigadier-General R. W. Bliss, assistant surgeon general, United States Army, said that, during a recent tour of the Pacific War theatre, he did not see one mosquito or fly. "When we first took over the Pacific Islands," he said, "there were clouds of insects everywhere, actually making it difficult to see. To-day, if we locate one mosquito, we consider it comparable to finding a four-leaf clover. To me, that's the outstanding achievement of medical science in this war." There were no malaria-carrying mosquitoes in Saipan, but there were species which carried dengue fever. After a few weeks of insect control, dengue fever, of which there had been a great many cases, practically disappeared. Medical sanitary companies divided the island into squares and drained and filled in swamps constantly. "The amazing D.D.T. insecticide, which did such a wonderful job in controlling typhus in Naples, was sprayed by hand and by planes."

Birds in Agriculture

DEFINITE evidence on bird behaviour is ever valuable, especially as regards agriculture, and Mr. A. Roebuck, of the Midland Agricultural College, has done well to put on record in the form of a leaflet five cases in which birds gave help to the farmer ("Birds in Agriculture"). By A. Roebuck, Midland Agricultural College, Sutton Bonington. Rooks, lapwings and black-headed gulls were the species that in these instances did much good work with regard to wireworms (*Agriotes obscurus*), dungbeetles (*Aphodius pinetarius* and *A. inquisitor*), leatherjackets (*Tipula paludosa*) and cutworms (*Agrotis segetum*). Of course, it has long been known that these birds take such agricultural pests, but here we have facts lucidly set forth that show how useful they are in the economy of the farm.

Empiricism and Descartes' Dream Situation

THE problem of determining the status of empirical propositions continues to exercise the minds and engross the attention of philosophers more than any other philosophical problem. The easy solutions of the logical positivists are being slowly torn to pieces by the more leisurely consideration of philosophers who, while sympathetic towards the general attempt to distinguish among propositions between the empirical sheep and the metaphysical goats, are yet suspicious of the ways of doing it. The attempt to

find an empirical content for all genuine propositions gives rise to a number of problems. In the seventeenth century, Descartes had expressed the view that as the senses sometimes deceive, they *might* do so always. Therefore he concluded that he might be dreaming, no matter how wide awake he seemed to himself to be. Can one maintain this position without self-contradiction?

In a paper "On the Relation of some Empirical Propositions to their Evidence" (*Mind*, Oct. 1944), Mr. C. Lewy discusses whether it is self-contradictory to say that "I have all the evidence which I do have for saying that I am not now dreaming, and however many tests I may make in the future, they will all confirm this evidence, but I am now dreaming" (p. 289). The paper is long, subtle and difficult to follow. The point of the discussion, when reached, consists in the author's showing that the first part of the statement quoted makes the demand that all the evidence that turns up should be positive, whereas the second part demands at least one piece of negative evidence. There could not be a situation which fulfilled these two conditions. The author concludes not, as might be expected, that the statement is self-contradictory, but that to the question whether it is or not, no answer is possible.

Fixing Confidence Limits to Measurements

IN a paper read in London by H. J. Josephs before the Institution of Electrical Engineers on January 19, the author discusses the problems involved in the application of simple tests of significance to small sets of measurements. The paper opens with an account of the *w*-test, which applies to normally distributed variables, and this is followed by a description of the *t*-test, which is of particular use in dealing with a small number of observations. A method of rapidly applying this test is given, and it is shown that if the true mean value of a physical quantity is unknown, the confidence limits to be attached to an estimated value obtained from the measurements may be determined easily. A quick method is described of estimating the standard deviation of a set of measurements, and it is shown that for very small samples the extreme-mean or median forms a good alternative to the arithmetic mean and is often easier to calculate. Pearson's χ^2 test of goodness-of-fit is explained and illustrated, emphasis being placed on the flexible nature of this test and its relationship to the *w*-test. The elementary tests of significance described involve only a small amount of simple arithmetic, so that they enable an engineer to replace guesses or tentative estimates by well-founded probabilities, and to assess the reliability of some of his results. No mention is made in the paper of the design of large-scale experiments, for which these simple tests are of value in rapidly analysing the data obtained from preliminary trials.

Earth Tremor of December 30, 1944, in Britain

A CONSIDERABLE number of personal experiences of the earth tremor have now been received, and it appears that in some places the tremor reached intensity 5 on the modified Mercalli scale (*Nature* Jan. 6, p. 15). In Yorkshire, the intensity was greatest in an elongated area near Skipton, and the only damage reported in this county was one chimney which developed a crack, possibly as the result of the shock, and had to be felled. An inquiry has

been made concerning possible sounds associated with the tremor, and three definite observations have been made, all supported by independent observation. (1) A rumble typical observation by Dr J. R. Ashworth, of Rochdale, who writes, "I heard a very audible rumble accompanying the swaying movement of the house" (2) A sound like a rushing wind, often said to have been followed by a thud, all taking place at the same time as the swaying (3) No sound - this was the experience of many who felt the tremor and "knew it could not be bombs because there was no sound" So far, no systematic geographical distribution of the observations of the different types is apparent In one area observations of all three types were reported Miss E. F. Bellamy, of the University Observatory, Oxford, felt the earth tremor; but the seismograph at the Observatory was not working at the time The tremor was not recorded on the disk of the Jagger shock recorder belonging to the British Association, then and now working at Comrie The tentative reading of the record of the tremor obtained by Mr E. W. Pollard at Binstead, Isle of Wight, shows that it recorded at 00h 36m 27s GMT, and Mr Pollard remarks that the record he obtained was similar to those resulting from "a tank passing at 100 yds, (2) a submarine depth charge at 5 miles, (3) the Burton explosion" No news has yet been received of any possible recordings by seismographs outside the British Isles

Report of Seismological Investigations Committee

THIS Committee of the British Association has just issued its report for 1944. This is its forty-ninth report, and it first records with regret the death of Dr. F. J. W. Whipple, who was chairman of the Committee during 1931-39. It is remarked that Whipple was primarily responsible for the leading place which Kew took in seismology, and it was also due in no small measure to his interest, enthusiasm and skill that the International Seismology Summary (published at Oxford) received such generous support from the International Geodetic and Geophysical Union. During the year there has been no alteration in the location or working of the instruments belonging to the Committee which are out on loan. The Milne-Shaw seismographs are at Oxford, Cape Town, Perth (Western Australia), Edinburgh and Fiji. There is also a clock at Fiji and a Jagger shock recorder at Comrie. Thanks are expressed to the collaborators. Two complete recording units have been dispatched to Bombay, and three spare clocks to Poona. Four Milne-Shaw seismographs are under construction for Bombay. Under war conditions, the preparation and publication of the International Seismological Summary is the sole responsibility of Miss E. F. Bellamy of the University Observatory, Oxford. The first quarter for 1935 has been published and partially distributed, while the computation is complete to the end of July 1935.

Committee on Aids for the Deaf

It has been announced in the House of Commons that the following committee has been appointed to advise and assist the Medical Research Council in promoting research into electro-acoustical problems relating to the design and application of instruments in alleviation of deafness. Dr. W. G. Radley (chairman), Mr. E. J. Barnes, Sir Lawrence Bragg, Mr. N. Fleming, Dr. C. S. Hallpike, Mr. L. C. Pocock and Dr. T. S. Littler (secretary). The Committee has

formulated a detailed programme of research, and investigations in which physicists are collaborating with otologists and physiologists are in progress.

Linear Intercepts, Areas and Volumes

IN the two theorems stated by S. I. Tomkeieff in a communication under this title in *Nature* of January 6, p. 24, the word "by" was printed instead of "to". The theorems should read as follows:

"1. The average linear intercept of a convex polygon circumscribed to a circle is equal to the average linear intercept of the circle."

"2. The average linear intercept of a convex polyhedron circumscribed to a sphere is equal to the average linear intercept of the sphere."

The Night Sky in February

NEW moon occurs on Feb 12d 17h 33m UT and full moon on Feb 27d 00h 07m. The following conjunctions with the moon take place: Feb 1d 03h, Jupiter 4° N, Feb 10d 22h, Mars 0 1° S, Feb 15d 20h, Venus 8° N, Feb 21d 21h, Saturn 0 6° N, Feb 28d 06h, Jupiter 3° S. The following occultations of stars brighter than magnitude 6 take place: Feb 19d 18h 24m, δ Taur (D), Feb 19d 19h 14m, δ Taur (D), Feb 19d 20h 09m, δ Taur (D), Feb 23d 2h 36m, δ Gemini (D). The times refer to the latitude of Greenwich and D refers to disappearance. Mercury rises at 7h 04m at the beginning of the month and is well placed for observation, on Feb 28 the planet is in superior conjunction when it rises at 7h 07m. Venus is an evening star and sets at 21h 10m and 21h 53m at the beginning and end of the month respectively. Mars is too close to the sun for favourable observation. Jupiter can be seen throughout the night, rising at 20h 54m and 18h 48m at the beginning and end of the month respectively. Saturn sets at 5h 41m on Feb 1 and at 3h 52m on Feb 28.

Announcements

PROF. HAROLD LASKI will deliver the first public lecture of the British Association of Chemists at the Caxton Hall, Westminster, on February 14, at 6.30 p.m. His subject will be "The Place of the Scientist in Post-War Administration". Anyone who is interested is invited to attend.

THE Maharaja of Travancore Lord Curzon Prize of the University of Madras has been awarded this year to Mr. S. Rajagopalan of the Indian Institute of Science, Bangalore, for his thesis "Essays in Chemotherapeutic Synthesis", representing the most meritorious original investigation in the physical sciences.

THE following appointments have recently been made in the Colonial Service: F. H. B. Blackburn to be agricultural chemist, Barbados, J. V. Harbord, to be agricultural superintendent, British Guiana, T. E. Ryall, to be agricultural officer, Nigeria, J. B. Smart, to be assistant conservator of forests, Kenya, A. Jefferiss, to be chief fruit inspector, Palestine, W. J. Badcock, agricultural officer, Uganda, to be senior agricultural officer, British Solomon Islands Protectorate, W. H. B. Buckhurst, assistant director of lands, mines and surveys, Fiji, to be director of lands, mines and surveys, Fiji.

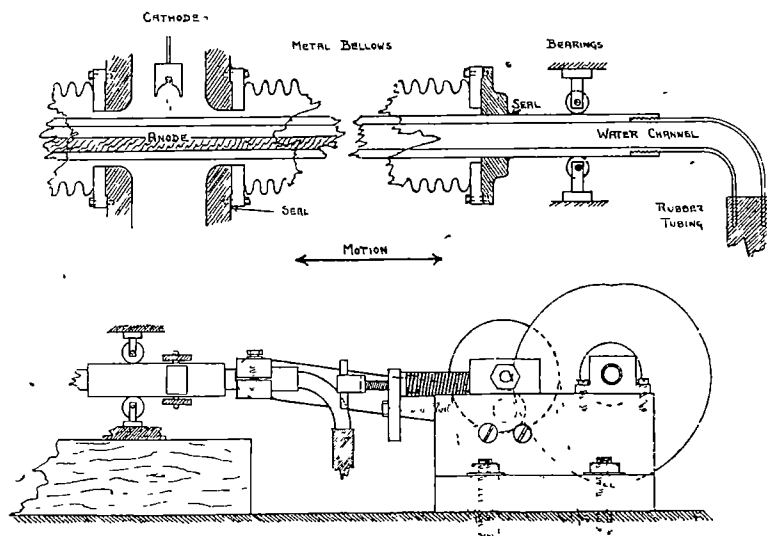
LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications.

A Simple Moving-Anode X-Ray Tube

THERE have now been described a number of moving-anode X-ray tubes, including the mercury-sealed type developed in this Laboratory¹⁻⁴, and their high performance may be regarded as established. They are, however, mostly expensive and not easy to build, and for the future welfare of X-ray structure analysis, particularly in the fibre and protein fields, something is needed for workers with modest resources—something that does not aim at the power that can be realized with a rotating anode, yet is considerably better than the stationary-anode tubes commonly in use. We have designed and constructed such a simple, demountable and inexpensive tube as follows.

The anode is a 5-ft. long horizontal copper tube, either of square cross-section or of circular cross-section with a plane surface in the central region, that is mounted on roller bearings at the two ends and oscillates with a stroke of 4 cm at 3 complete oscillations per second. The vacuum is maintained by two lengths of metal bellows sealed on to the X-ray tube at their inner ends and on to the anode at their outer ends (see upper diagram). The drive is by means of a con-rod and wheel, belt-driven from a light Klaxon reduction gear, but to avoid repeated stationary points at the ends of the simple harmonic motion the axle of the wheel is also moved more slowly backwards and forwards over a $\frac{1}{2}$ -in. path by means of a friction drive against a cam (see lower diagram). The fast stream of water that passes along the central bore of the anode is admitted and taken away by pieces of stout rubber tubing at right angles to its length, so as to eliminate shaking by the oscillation. Also, to attain the speed and turbulence for efficient cooling, the bore at the focal-spot region is suitably constricted, for example, by a wooden insert.



This first model is admittedly experimental, and we envisage improvements in the near future as regards design of target, its distance from the X-ray windows, and neutralization of end-effects; but results obtained already are so gratifying that it is worth while quoting some of the principal dimensional features. The central flat of the anode is rather more than $\frac{1}{2}$ in across and its thickness with respect to the water flowing underneath is 2 mm. The metal bellows (the present pair were supplied by the Power Flexible Tubing Co., Ltd.) are each about 18 in long and 2 in external diameter, and so far they have oscillated for many hours without showing any signs of injury. (They are of the usual copper-zinc alloy, but we anticipate considerable advantages in elasticity and fatigue limit from the new copper-beryllium alloy that has recently been described⁵. Other seals are also possible.) The tube, of hot-cathode type (but, of course, moving anodes are equally applicable to gas tubes), incorporates two water-cooled windows (an important feature uncommon in rotating-anode tubes), an insulating body consisting of a miner's lamp glass as in the Shearer gas tube, and the tantalum filament, focusing cup and cathode already found advantageous in producing a sharp line-focus^{3,4}. This line-focus (at right angles to the length of the anode) foreshortens, for an emergent beam at 6° to the horizontal, to an area effectively $0.75 \text{ mm} \times 0.6 \text{ mm}$, with such a focus we have run the tube at 44 ma and 28 kV. and taken good photographs of ramie in 2 minutes at $D 2 \text{ cm}$ with a $\frac{1}{2} \text{ mm}$ slit.

The whole apparatus is remarkably quiet and unobtrusive—it may be mounted centrally along the usual laboratory bench with a spectrometer on each side and the pumping equipment immediately underneath. An adaptation that suggests itself is to have a single (longer) anode, sealed by a single pair of bellows, running through a series of X-ray tubes on the same bench, and it would be possible, too, to have a composite anode that included sections made from different

metals. Two similar tubes, with a common anode and set at the requisite distance apart, might form an excellent arrangement for the purposes of high-speed stereoscopic radiography.

Full details will be published elsewhere. The junior author thanks the International Wool Secretariat for tenure of a research fellowship.

W. T. ASTBURY
I. MACARTHUR

Textile Physics Laboratory,
University of Leeds
Dec 12

¹ Astbury and Preston, *Nature*, 133, 460 (1934)

² Astbury, Meeting of X-Ray Analysis Group of Institute of Physics, Leeds, November 25, 1944

³ Green, Ph.D. Thesis, University of Leeds (1938)

⁴ MacArthur, *Electronic Eng.*, Pt 1, 272 (Dec 1944), Pt 2, in the press Meeting of X-Ray Analysis Group of Institute of Physics, Leeds, November 25, 1944

⁵ Hunt, *J. Sci. Instr.*, 21, 97 (1944)

Nuclear Histone from Bird Erythrocytes in the Preparation of Insoluble Insulin Compounds

FOLLOWING early work done in these laboratories the use of thymus histone for the preparation of histone-zinc-insulin with prolonged hypoglycaemic activity¹, we have now tried a histone from the nucleus of bird erythrocytes.

Drs. Lajmanovich and Mittelman directed our attention to this protein, it is usually classified as histone, but they found in some reactions that it shows some properties of the protamines. We thank them for preparing the histone we employed, from turkey erythrocytes, by a modification of the method Kossel².

A suspension of histone-zinc-insulin (histone from erythrocytes), at pH 6.8, and containing 40 i.u. insulin per c.c., was prepared by the usual procedure. When administered to diabetic dogs, a fall in the blood glucose took place that lasted for a little more than twenty-four hours, when the initial glycaemic level was again obtained.

The type of glycaemic curve (glycaemia-hours) was similar to that obtained when the same amount of protamine-zinc-insulin (protamine-salmin) was administered. The hypoglycaemic action of the same amount of histone-zinc-insulin (thymus histone) was very so prolonged.

In conclusion, it can be stated that the histone-zinc-insulin complex prepared with histone from the nucleus of turkey erythrocytes has a hypoglycaemic activity more like that of protamine-zinc-insulin than that of the thymus histone-zinc-insulin preparation.

LFREDO BLASOTTI
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Blasotti, Deulofeu and Mendive, *Nature*, **138**, 1101 (1936). Blasotti, Deulofeu, Mendive and Patalano, *Medicina*, **3**, 442 (1943). Lajmanovich and Mittelman, *Rev. Inst. Bact.*, **12**, 320 (1944).

Detection of Chemotherapeutics in Thin Sections of Tissue by the Aid of Fluorescence Microscopy

It has long been known that, thanks to the property of showing fluorescence in ultra-violet light, many substances can be demonstrated even in very low concentrations. As a large number of the common drugs show fluorescence, it would appear reasonable to endeavour to demonstrate their presence also in tissues by the aid of fluorescence microscopy. The method has not been used very greatly, however, in view of the fact that the natural fluorescence of the tissues is so strongly blue that it masks the fluorescence of the drugs administered. In addition, the histological methods used have not excluded the possibility of changes in the locality and concentration of the substance sought during the actual preparation.

We have therefore adopted Altmann-Gersh's freezing method for fixing and drying the sections, in which I have made use of a modification which has recently been described in detail by F. Sjöstrand¹. The principle is as follows. The organs and pieces of tissue to be studied are removed and immediately

frozen in liquid air. They are then dried over phosphorus pentoxide *in vacuo* in a refrigerator at about -40°C . They are embedded in paraffin and cut into histological sections, which are mounted on slides, and are then ready for microscopical examination.

Drugs of which the fluorescence colour is other than blue can be demonstrated directly in the sections. For example, Prontosil rubrum and soluble, which have a strong red fluorescence, can be demonstrated² even in a concentration of 1×10^{-10} g per μ^2 , which is a considerably greater sensitivity than that obtained by observing the natural colour in an ordinary light microscope.

Drugs with blue fluorescence can frequently be made to change their fluorescence colour by heating in a small electric oven to different temperatures for different lengths of time. Sulphathiazole, for example, turns yellow on being heated to 170°C for 5 minutes, the tissue itself remaining blue. This produces a beautiful contrast, allowing of the location of sulphathiazole in tissues and cells. In an ordinary light microscope, no traces of sulphathiazole can be discovered in such sections, any more than is possible in a fluorescence microscope before heating.

By the aid of this method it is possible to demonstrate the presence of a number of drugs, for example, sulphanilamide, sulphapyridine, papaverine, insulin (yellow after 3 min at 200°C , the tissues still being blue), etc. Penicillin, which has a green fluorescence, can be identified without difficulty in muscle after an intramuscular injection and after the sections have been heated to 175°C for 5 min, the penicillin is then yellow-brown. In some cases the contrasts are obtained by the substance sought keeping its colour, while the tissues change their fluorescence colour. Sodium salicylate, which has a blue fluorescence, can thus be demonstrated at 200°C after 5 min, the tissues at that temperature being yellow.

As the natural fluorescence is considerably differentiated, no special staining is necessary to facilitate the identification of the tissues.

By the aid of this method it has proved possible to study in detail the location of chemotherapeutic substances in tissues and their secretion.

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¹ Sjöstrand, F., "Über die Eigenfluoreszenz tierischer Gewebe mit besonderer Berücksichtigung der Säugetiere" (Stockholm, 1944).

² Helander, S., "Nachweis von Prontosil löslich in histologischen Gewebsschnitten mit Hilfe der Fluoreszenzmikroskopie", *Acta phys. Scand.* (1944).

Detection and Determination of Traces of Methyl Bromide

METHYL bromide has many advantages as a fumigant, but suffers from the disadvantage that over a range of concentrations liable to be encountered during airing, it is harmful to man and not detectable by smell.

The current method of detection, which does not serve for determination, depends on the appearance of a green 'copper' colour in the flame of a Halide detector lamp. This method is, of course, not specific to bromide and is inconvenient under many practical

conditions. A method free from some of these objections has now been devised. It depends on the catalytic combustion of traces of methyl bromide in air on a glowing platinum wire and the determination of the bromine liberated by the coloration of a test paper. The paper is wetted with a pale yellow solution of fluorescein, more or less of which is changed to red eosin according to the amount of methyl bromide decomposed. The apparatus, which is portable, consists of a vertical glass tube towards the bottom of which is mounted a platinum spiral which can be caused to glow by the passage of a current from a small 4-volt cell. The test paper, which is perforated in the middle, is fastened over the top end of the tube. When the current is switched on, a stream of air passes over the spiral and up the tube, which acts as a chimney, and the eosin, which appears as a ring on the paper surrounded by a white border, can readily be matched against standard disks.

By using different periods of testing and different colour standards, determinations of traces of methyl bromide can readily be made over a wide range of concentrations covering those which are of toxicological importance.

A fuller account of this method is being published elsewhere.

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Extraction of Phospholipids in Salmon Roe

IN the course of investigations on salmon roe globulin, the interesting observation was made that the phospholipids in the roe are so strongly held by the proteins that non-polar or semi-polar solvents with a low boiling point (pentane, light petroleum, ethyl ether) do not extract any phospholipid at all from salmon roe, which was previously dried at a temperature below 40° C, although the oil can be completely extracted by such solvents.

It was found by Hoppe-Seyler¹ and others that egg yolk lecithin and phospholipids from other sources are partly extractable with light petroleum or ethyl ether, but that their complete removal could only be accomplished by using a polar solvent such as methyl or ethyl alcohol. In no case, however, did he obtain a complete separation of the oil from the phospholipids. Only milk phospholipids have been reported to differ in this respect. Osborne and Wakeman^{2,3} found that the phospholipids of milk precipitated together with the proteins were not extracted at all by ethyl ether, although a subsequent treatment with alcohol removed a considerable amount. These authors stated that the non-protein-containing fraction of milk contains phosphorus. Such findings are understandable for milk, which contains only about 27 mgm of phospholipids per litre, but it was surprising to find no phospholipids in the solvent-extracted oil from salmon roe, while a subsequent extraction with alcohol removed on the average 6 per cent phospholipids. This is about 2,000 times the amount found in milk.

Experiments with salmon roe were as follows. Fresh salmon roe was dried at 30° C in the stream of air from a fan. The dried material was ground to 20-30 mesh and extracted with pentane in a

Soxhlet apparatus. The oil obtained by this method contained the pigments, but no phosphorus, shown by ashing and testing with ammonium molybdate.

The pentane-extracted roe was reground to 50-mesh, and thoroughly extracted with methanol in same Soxhlet apparatus. The phospholipids so obtained had a reddish-brown, waxy appearance, a characteristic odour. They were free from phosphorus. The ash content was about 10 per cent, the phosphorus content between 2.9 and 3.4 per cent, moisture content 3-5 per cent.

On the average, the roe from sockeye salmon (*Oncorhynchus nerka*) yielded by the above method 12.5 per cent oil and 6.2 per cent phospholipids.

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¹ Hoppe-Seyler, T., *Hoppe-Seyler Med. Chem. Unters.*, **3**, 392 (1861).

² Osborne, T. B., and Wakeman, J., *Biol. Chem.*, **21**, 539 (1915).

³ Osborne, T. B., and Wakeman, J., *Biol. Chem.*, **23**, 1 (1916).

Apparent Clearing of the Sky at Dusk

CLOUDS may disappear by evaporation of droplets, a purely physical effect, but they may also vanish to the eye, though in fact they remain. It is generally accepted that the eye can distinguish between brightnesses down to the limit of 2 per cent difference, which may be termed the discrimination factor. The best papers on this factor and its variation with intensity are those of Nutting¹ and Hecht². Average daylight for good eyes, the factor may be as low as 1 per cent, increasing for very bright light to about 6 per cent, and for much-reduced illumination rising steeply to more than 60 per cent, but a value of 2 per cent holds approximately over a wide range of daylight.

This variation gives the explanation of 'the moonlight effect', since in shadows the general illumination is so low that the discrimination factor rises by the difference between adjacent objects which daylight were distinguishable. Precisely the same explanation holds good in the sky, where differences in brightness are not distinguishable in reduced light in which discrimination may require a 5, 10 or 20 per cent difference. For example, Hewson³ has calculated that radiation from a source at 25° zenith distance is reduced by 6.6 per cent in intensity in passing through 20 metres of cloud having droplets of 1 µm diameter and a droplet water content of 0.1 gm. per cubic metre, as in high cloud. The loss is due to reflection, absorption being negligible for daylight. Against a dark sky such a cloud is therefore visible until the discrimination factor approaches 7 per cent, which occurs when sky brightness is about 0.01 millilamberts, shortly before the end of civil twilight. A similar cloud 200 m thick reflects approximately 40 per cent, and ceases to be discriminable when brightness is reduced to 0.0003 millilamberts, near about the end of nautical twilight.

There is also another factor tending to lessen the visibility of clouds at dusk. A cloud appears white against the blue sky because the latter scatters light predominantly blue and the former reflects or scatters light from the sun. But when the sun is down, clouds are illuminated only by scattered light and starlight. They thus approach more closely to blue—the spectral region to which our eyes are most sensitive.

pted eyes are more sensitive. This lessening of ur difference has a considerable effect in reducing trast, as may be seen by viewing a sky with tered broken cloud through a blue glass. Viewing ough an orange or light-red glass increases cont. With a deep-red glass, however, the dis- mination factor may be raised and so again trast difference is reduced.

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Nov. 27.

ting, P. G., *Trans. Illum. Eng. Soc.*, N.Y. 11, 939 (1916)

ht, S., *J. Gen. Physiol.*, 11, 255 (1928)

son, E. W., *Quart. J. Roy. Met. Soc.*, 69, 47 (1943)

Causality or Indeterminism?

Nature of November 25, Prof. E. T. Whittaker: "If a coin is tossed a thousand times and the number of occurrences of heads recorded, and if this experiment is repeated a very great number of times, there will be a statistical regularity in the records, which may be calculated by the ordinary theory of probability. Does the calculation involve only assumption (as regards the tossing) that there is symmetry in the system?"

Does this not assume that the hand—or machine—which tosses the coin moves in a 'random' manner? Is an assumption often made, and the result treated as if it were an axiom. Is there, in fact, any natural reason for it? Would not the hand—the machine—tend to move in a systematic manner and thus produce a biased result if the coin were repeated many thousands of times? Is the assumption of symmetry appears to be a conclusion of the experiment yielding the hypothesized result, it is clearly not justified by examination of an ordinary coin as a human tosses—which is asymmetric—necessarily so if it is to achieve the purpose which it is tossed.

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Nature of November 25 there is a letter from W. W. Barkas together with Prof. E. T. Whittaker's answer, concerning determinism. The reply refers *inter alia* to some experiment, which is apparently very famous, as during the last century nearly every book or treatise devoted to probability cites, cribes or refers to, the so-called experiment of tossing a coin, or dice, etc. However, I have some doubts if any of the authors referring to this 'experiment' ever attempted to treat it as an experiment, that is, to repeat it.

As I have done so, although under somewhat improvised conditions, I would like to mention the results obtained, as they may be of interest to someone else.

I designed a simple device, by which the chosen coin, in fact, a new sixpenny piece, can be placed always in the same relation to the apparatus. A mechanically operated lever tosses the coin upwards a rather small distance with the same pressure exerted in the same mode of time and on the same portion of coin, when used. The coin falls on a wooden surface covered with cloth, namely, an ordinary writing-desk. Before reaching the desk, the coin revolves several times in

the air and after touching the surface it rebounds, as may be expected. The results after tossing the coin a hundred times with head initially up, it rested with head up ninety-eight times. After adjusting the lever to a slightly different pressure exerted in the next hundred tossings, also with head initially up, the coin fell with head up once only.

I cannot say I was astonished, as I expected such a result, but it seems to me that it proves that the 'chance' of occurrence of head in tossing a coin is simply the result of the force applied, and consequently this experiment has nothing to do with indeterminism in the sense implied by Prof. Whittaker. On the contrary, as the two or one exceptions in position in which the coin falls are obviously caused by slightly uneven pressure (in force and duration) exerted by the rather improvised device, the experiment, after being repeated under strictly controlled conditions, is more likely to be used by advocates of determinism.

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MR. BARKAS in his letter in *Nature* of November 25 says, "My difficulty is that if the final result of, say, one million, or billion, photons is regular (that is, determined), then how can the choice of any one be individually indeterminate". I should like to point out that the final result is not strictly regular or determined. With increasing numbers of photons, the fluctuations about the mean become less and less proportionally significant, until, for many purposes, they can be left out of account. The same is true of the pressure of a gas. If we calculate the pressure from observations on a surface sufficiently large, then the fluctuations may be altogether inconsiderable and the pressure can be regarded as constant, but if we take a surface sufficiently small—say, for example, a smoke particle—then the fluctuations will be large and will be the origin of the characteristic Brownian movement.

I should like to point out further that the argument Mr. Barkas quotes from the Guthrie Lecture cannot be sustained as disproving causality. What, under certain conditions, it does show is that causality fails if parameters are restricted to photons. Clearly, however, in the passage of photons through Iceland spar, parameters associated with the crystal lattice must be taken into account, and when this is done, the argument fails. Apparently von Neumann's argument has a similar weakness¹.

A large number of the facts of modern physics can be unified by means of non-causal laws, but no case, so far as I know, has yet occurred where causal explanations can be ruled out as impossible. Natural phenomena, as we see them, may indeed permit of unifying descriptions from two totally different points of view. Perhaps, alas, both types of description may fail.

Determinism is probably not applicable outside material phenomena, but in regard to these it has proved a very useful philosophical principle for hundreds of years. Caution is therefore necessary before it is thought of as having 'collapsed'.

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¹ Pelzer, *Proc. Phys. Soc.*, 56, 195 (1944)

Semi-conducting Properties of Stannous Sulphide

In a previous communication¹, we reported that two mechanisms are discernible in the electrical conductivity of stannous sulphide: positive-hole conduction, depending on the departure of the material from stoichiometric composition; and, at higher temperatures, a second mechanism with higher activation energy, fairly reproducible from one sample to another. This high-temperature conduction, we suggested, represents the intrinsic electronic conductivity of the crystal lattice.

We have recently obtained evidence confirming this view from simultaneous measurements, over a wide temperature range, of (a) the conductivity and (b) the thermo-electric effect of the couple gold-stannous sulphide-gold. At temperatures corresponding to the first leg of the log (conductivity) - $1/T$ curve, the direction of the thermo-electromotive force is indicative of positive-hole conduction (plotted as positive in the graph), its magnitude varies with the stoichiometric composition of the sulphide (0.5-0.6 millivolts per degree for well-conducting material, with activation energy of conduction 0.16 e.v.; 0.8-1.0 millivolts/degree for the same specimen after hydrogen treatment, with $E_1 = 0.43$ e.v.), but varies little with temperature while only one conduction process is effectually operative. At temperatures approaching the discontinuity in the log conductivity - $1/T$ curve, the Seebeck electromotive force decreases, becoming negative at temperatures rather above the onset of the high-temperature conduction process (see graph). At high temperatures the current carriers are therefore electrons, and the activation energy of conduction can be regarded as the energy of excitation of an electron to the conduction band of the crystal.

Schottky and Waibel² observed an analogous change in the magnitude and sign of the Hall

coefficient of cuprous oxide (also a positive-hole conductor at ordinary temperatures, due to stoichiometric excess of oxygen) at temperatures in the break in the conductivity curve. The behavior of stannous sulphide thus provides a second instance of the clear identification of the intrinsic conductivity of a semi-conductor.

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¹ *Nature*, 152, 75 (1943), full account in course of publication.

² *Phys. Z.*, 38, 912 (1935)

Serological Reactions Caused by the Rare Human Gene Rh_z

A RARE allelomorph of the Rh gene has been described^{1,2} and provisionally denoted by Rh_y . This gene differs from the six Rh allelomorphs previously found in giving a negative reaction with γ serum but at the same time a positive reaction with serum. The Greek letters here used for the Rh antibodies are those suggested by Fisher³, but various names have been used.

Γ = anti- Rh_1 (more recently anti- Rh' , Wiener)
 $\rho h o_1$ = serum 1 (Murray)

γ = St = serum 4

Δ = standard 85 per cent reacting = $\rho h o$ = serum

H = anti- Rh_z (more recently anti- Rh'') = serum

The reactions of this allelomorph ' Rh_y ' with the other two antibodies Γ and Δ were unknown, since in the examples found it had as partner the gene Rh which is itself positive with these two antibodies. Consequently the reaction of the rare gene *per se* was obscured.

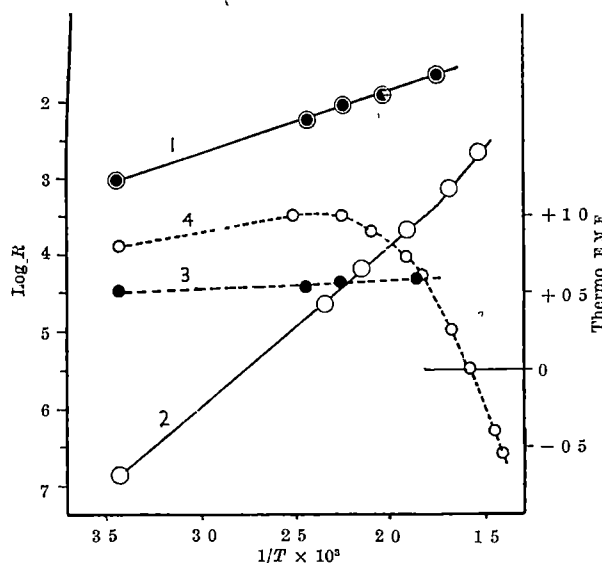
On theoretical grounds, Fisher³ considered that there were probably two genes which were γ negative and H positive, and predicted that one would be Δ negative and the other Δ positive, and that both would be Γ positive. One he called Rh_y and the other Rh_z and assigned to them these reactions:

	Γ	γ	Δ	H
Rh_y	+	-	-	+
Rh_z	+	-	+	+

A family has recently been examined in which the father's blood was of the type γ negative H positive which we would previously have called Rh_1Rh_y . The father was the second person in whom this rare gene was found. In a child by his second wife, the rare gene is caught in combination with rh , so that the reactions with Γ and Δ are no longer obscured by disclose themselves (for rh is negative with both these antibodies). The child's blood was Γ positive and Δ positive, so that the gene present is Fisher Rh_z . Had the child got Rh_1 from its father its cell would have been negative with H , for Rh_1rh + + + -.

Fisher's main hypothesis gains some support since it demanded that neither Rh_z nor Rh_y would be negative. If later this theory is fully substantiated the symbols Rh_y and Rh_z will be equivalent to the antigenic formulae CdE and CDE .

In previous communications^{1,2,4}, certain bloods have been called genotype Rh_1Rh_y , they may have been Rh_1Rh_y or Rh_1Rh_z . In the family here described

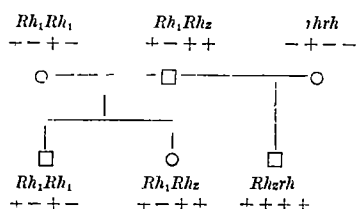


Curve 1 LOG R - $1/T$ CURVE FOR SUBLIMED STANNOUS SULPHIDE

Curve 2 SAME, AFTER TREATMENT WITH HYDROGEN AT 250°

Curve 3 THERMO-ELECTROMOTIVE FORCE - $1/T$ CURVE FOR SUBLIMED MATERIAL

Curve 4 THERMO-ELECTROMOTIVE FORCE CURVE OF MATERIAL AFTER HYDROGEN TREATMENT



Order of sera, Γ γ Δ H . This is not the order used in some earlier communications, which was Δ γ H Γ .

None of four families examined, has the rare gene segregated in such a way that its reaction with all our antibodies could be determined, they have turned out to be those proposed by Fisher for Rh_2 , the proof of the existence of Rh_y as an eighth gene will probably have to await an equally fortunate segregation.

The scheme previously published³ is here given again with the necessary alterations

Genes	Γ	γ	Δ	H
Rh_2	+	-	+	+
Rh_1	+	-	+	+
Rh_y	(+)	(-)	(-)	(-)
Rh'	+	-	-	-
Rh_2	-	+	+	+
Rh_0	-	+	+	-
Rh''	-	+	-	-
rh	-	+	-	-

Those reactions not yet determined serologically are given in brackets.

Sera of the Γ , Δ and H types, kindly sent from America by Dr A S Wiener, gave with the bloods of this family the same reactions as our sera.

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Medical Research Council
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Race, Taylor, Boorman and Dodd, *Nature*, 152, 563 (1943)
Race, Taylor, Cappell and McFarlane, *Nature*, 153, 52 (1944)
Race, *Nature*, 153, 771 (1944)
Race and Taylor, *Nature*, 153, 560 (1944)

Devernalization by High Temperature

THE possibility of devernalization by high temperature was demonstrated in previous work¹, but the aim then was to show that it is low temperature rather than restriction of growth which is the determining factor in vernalization. To separate these factors, anaerobic conditions were imposed during the period of high-temperature treatment, and misconceptions have arisen as to the validity of the results on this ground^{2,3,4}.

Interest in vernalization has led to further work in the USSR by Efekim and by Tetjurev. The former⁵ showed that 45 days of vernalization in winter wheat ('Durable') may be annulled completely in 4-5 days at 34-35°C, while one day's exposure to this temperature reduced ear production to 66 per cent of that of the vernalized but unheated controls. Similar results were obtained by Tetjurev⁶. The devernalizing effect of high temperature has been confirmed by us. Winter rye (var *tekus*) was vernalized for 42 days at 1°C and the seed was subjected to a range of temperatures for varying periods of time. The tempera-

TABLE 1 EFFECT OF TREATMENT AT 35°C BEFORE SOWING ON THE RATE OF EAR DEVELOPMENT (1) IN WINTER RYE VERNALIZED 42 DAYS AT 1°C, AND (2) IN SPRING RYE

Duration of heat treatment	Spring rye (unvernalized)		Winter rye (vernalized)	
	'Score'	No of replicates	'Score'	No of replicates
0 (Controls)	123 ± 0.12	(52)	100 ± 3.0	(47)
8 hours	120 ± 0.77	(48)	95 ± 4.6	(44)
16 "	121 ± 0.93	(53)	90 ± 4.9	(35)
1 day	120 ± 0.65	(62)	75 ± 6.5	(35)
2 days	121 ± 0.68	(47)	80 ± 5.9	(39)
3 "	124 ± 0.40	(55)	72 ± 9.5	(16)
4 "	123 ± 0.46	(49)	72 ± 6.4	(33)
5 "	120 ± 0.64	(42)	63 ± 6.6	(35)

tures used were 25°, 30°, 35° and 40°C, and the durations of heat treatment were 8 and 16 hours, 1, 2, 3, 4, 5, 6 and 10 days. The full details will be presented later, here the results for 35° only are given.

Spring rye (var *Petkus*) was subjected to similar heat treatments without previous low-temperature treatment. The results obtained are entered in Table 1.

The values entered in the Table are means of 'scores' assigned to the individual plants to denote the stage of development reached by the ears at the end of the experiment, the higher the value the more advanced the ear. The method of scoring is discussed elsewhere⁷. A score of less than 50 denotes a stage between an undifferentiated stem apex and the dehiscence of the anthers, and is determined by dissection of the main axis of the plant. Values above 50 denote, by difference from the numbers entered, the number of days elapsed after the ear has passed beyond the stage of anthesis. The entries enclosed in brackets are the number of replicates on which the mean value is based. The score attained in this experiment by unvernallized winter rye was 22 ± 0.63 with 40 replications.

The following conclusions may be drawn: (1) Heat treatment of the seed is without effect on the flowering behaviour of spring rye. This shows that there is no question of a lethal action concerned. Spring rye heated at 40°C for 4 days scored 120, thus substantially the same as at 35°C. It may therefore be assumed that the reduction in score seen in winter rye is not due to any injury effect. (2) A progressive reduction in the score accompanies prolonged heat treatment of winter rye, and the downward trend is statistically significant. The delay in flowering is then, presumably, due to the reversal of the vernalization effect. It is interesting to note that in these experiments no complete devernalization occurred. After treatment at 40°C for 2 days the score was 79 ± 8.0, that is, four times that of unvernallized winter rye, whereas a further day at 40°C killed all the seed.

Further proof that the delay in flowering noted

TABLE 2 REVERNALIZATION OF WINTER RYE, AFTER HEAT TREATMENT, BY A FURTHER PERIOD OF 6 WEEKS AT 1°C

Duration of heat treatment	'Score'	No of replicates
0 (Controls vernalized 12 continuous weeks at 1°C)	112 ± 1.18	(17)
8 hours	113 ± 0.95	(48)
16 "	117 ± 0.82	(41)
1 day	117 ± 0.45	(42)
2 days	113 ± 0.93	(39)
3 "	118 ± 0.65	(54)
4 "	117 ± 0.63	(54)
5 "	116 ± 0.65	(55)

was a true reversal of vernalization was provided by the following experiment. After the preliminary vernalization for 42 days at 1° C., and the following heat treatment for varying durations and temperatures, the seeds were exposed to low temperature for a further six weeks, thus receiving in all twelve weeks at 1° C. The effect on ear development is shown by the scores given in Table 2.

The scores are thus slightly higher than those of the control series which had been vernalized for an unbroken period of twelve weeks. The absence of any effect of heat treatment on spring rye, and the possibility of reversionalization by low temperature after the heat treatment, proves beyond doubt the possibility of reversing the normal vernalization process.

An interesting effect noted in the course of this work is that the efficacy of the high-temperature treatment in reversing vernalization depends upon the duration of the previous low-temperature period, and thus upon the 'intensity' of vernalization. This aspect is now the subject of further investigation.

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Dec. 14.

¹ Gregory, F. G., and Purvis, O. N., *Ann. Bot.*, N.S., 2, 753 (1938).

² Whyte, R. O., *Biol. Rev.*, 14, 51 (1939).

³ M. A. O., *Herb. Rev.*, 8, 83 (1940).

⁴ Bassarskaya, M. A., and Grossman, V. Ju., *Herb. Abstr. Suppl.* II, 11, 11 (1941).

⁵ Efeikin, A. K., *CR Acad. Sci. U.S.S.R.*, 30 (7), 661 (1941).

⁶ Tetjuev, V. A., *CR Acad. Sci. U.S.S.R.*, 30 (2), 189 (1940).

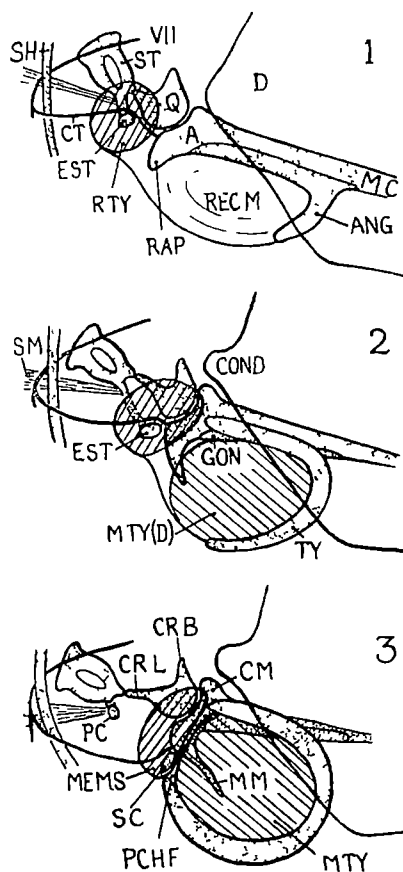
⁷ Gregory, F. G., and Purvis, O. N., *Ann. Bot.* N.S., 2, 237 (1938).

The Mammalian Middle Ear

In a recent communication in *Nature*¹, certain implications of new work on the anatomy of the middle ear region of mammal-like reptiles were discussed. Some further aspects of the evolution of the mammalian middle ear are here briefly noticed. A new synthesis, based on palaeontological evidence, was recently offered² to 'explain' the nature of the mammalian tympanic cavity. It was suggested that the primitive reptilian tympanic cavity was, in at least some therapsids, supplemented by a recessus mandibularis related to the region of the notched angular bone, and that the mammalian tympanic membrane was formed from the thin external wall of this recess by extension of the old tympanic membrane.

A feature of the mammalian tympanic region, not found in living 'lower' tetrapods, is the presence of the membrana Shrapnelli, or 'pars flaccida' of the tympanic membrane. As pointed out long ago (reviewed by Bondy³), this structure is not really part of the tympanic membrane, from which it is separated in the human subject by the anterior and posterior malleolar folds, which are variously developed in other mammals (the anterior and posterior "Chordafalten" of Bondy). So far as I am aware, Shrapnell's membrane and the *Chordafalten* have never been adequately discussed from the phylogenetic point of view. In the earlier work² they were not discussed, but they can be shown to fall clearly into place and to modify some of the details previously set forth.

Shrapnell's membrane seems with great probability to represent the remains of the 'reptilian'



Three suggested stages (diagrammatic) in the evolution of the mammalian middle ear from an advanced theriodont (a cynodont). A, articular, ANG, angular, CM, caput mallei, COND, condyle of dentary, CRB, crus brevis, CRL, crus longus, CT, chorda tympani, D, dentary, EST, distal part of extrastapes, GON, gonial, MC, Meckel's cartilage, MEMS, membrana Shrapnelli, MM, manubrium mallei, MTY, mammalian tympanum, MTY(D), developing mammalian tympanum, PC, Pauw's cartilage, PCHF, posterior "Chordafalte", Q, quadrate (incus of mammals), RAP, retro-articular process, RECM, recessus mandibularis, RTY, reptilian tympanum, SC, Spence's cartilage, SH, stylohyal, SM, stapedial muscle, ST, stapes, TY, tympanic bone, VII, facial nerve.

tympanum of therapsids. Its relations to Spence's cartilage (which probably gives rise to Bondy's "Chordafortsatz"^{3,4,5}) support the previous identification¹ of this element with the separated distal part of the extrastapedial. The course of the chorda tympani, allowing for the functional degeneracy of the extrastapedial, also favours this interpretation. Moreover, Shrapnell's membrane (in mammal where it forms part of the outer wall of the eptympanic recess), and the bony walls of the recess, have similar relations to those between the 'reptilian' tympanic membrane of some therapsid and the corresponding part of the bony skull, which differs considerably from the homologous region in living reptiles, the main difference is that Shrapnell's membrane normally extends forward to the anterior limb of the tympanic in mammals, and meets the malleus. This difference seems to be due to change in proportions of the region of the old reptilian jaw articulation, and to slight lateral movement (relative to the articulation) of the 'reptilian' tympanum and external auditory meatus, during the transition to mammals. The latter is distinctly indicated by the

tion of the groove for the meatus on the posterior of the squamosal in many therapsids such changes would bring the 'reptilian' tympanic membrane over the back of the articular. This also well into the scheme of regional plastic changes he skull during the therapsid-mammal transition recently described⁶. It is probable that the process lateralis of the malleus is a relic of an earlier attachment of a tympanic membrane on the articular probably of the old reptilian tympanum at a stage in the dentalo-squamosal articulation had become adult jaw articulation, so that the articular was relatively immobile.

The *Chordafalten* would then seem to be the reduced and compressed equivalent of the tissues which laterally separated the upper part of the tympanic cavity of therapsids from the recessus mandibularis. Their relations to the chorda tympani, the malleus and goniale, to the tensor tympani and to the enlarged tympanic annulus, can readily be understood in this way (cf Figs 1-3). It should be noted that a compressed posterior *Chordafalte* would not result if a depressor mandibulae muscle of many reptilian ('sauropsid') type were present in the higher therapsids the 'loose' quadrate and the delicately built articular region make it clear that the jaw musculature cannot have been easily comparable with that in, for example, lizards. It seems probable that at least some of the more mammal-like reptiles had already some 'mammalian' characters in the muscles for opening the jaws. In extremes this is done by the detrahens mandibulae (slip from the adductor externus group), while in mammals have developed a digastric (from the rmandibularis and interhyoideus musculature).

It supports the suggestion that mammals are not paraphyletic. Parallel evolution in higher therapsids is well known, and in many structures the trend towards a mammalian pattern. Olson⁷ has recently demonstrated several new and striking trends. If more than one therapsid stock gave rise to mammals, great similarity in the tympanic membrane and related structures in all mammals suggests either a further example of very closely parallel evolution, or, at least some therapsids, the outer membrane wall of the recessus mandibularis had already assumed some kind of tympanic function. The therapsid and sauropsid reptiles differ in so many ways that any advance in understanding of these problems can come only from palaeontological evidence combined with a study of the anatomy (particularly developmental) of generalized mammals. Finally, it should be noted that the accessory 'mal' elements associated with the malleus may be correctly homologized within the group. The zulum accessorium malleoli and the goniale need most careful re-investigation, but their relations to *Thrysochlois* in particular support the tentative hypotheses previously suggested¹.

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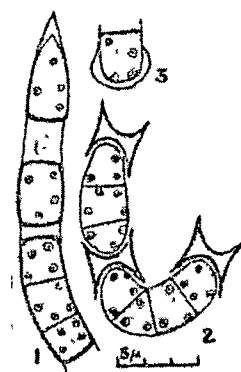
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Nov 24.

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New Observations on *Uronema*

Uronema indicum growing as an epiphyte on aquatic plants in July at Allahabad, India, has been studied in natural as well as cultural conditions. In Nature the filaments were about 6 mm long, but in culture they attained a length of 4.2 cm. The cells showed wide variations, even in Nature. Usually they were 14-19 μ long and 6-14 μ broad and had a chloroplast occupying the whole length of the cell. In many cases the cells, especially those near the tip, were much longer (40-3 μ) and had the chloroplast only in the middle. The size of the filament and cells and the extent of the chloroplast within the cell have been made the chief features for differentiating the various species of *Uronema*. The above observations show that such variations may also be due to ecological conditions.



No method by which *Uronema* perennates has so far been reported. This species was found to perennate by means of akinetes under both natural and cultural conditions. The akinetes were formed in Nature on desiccation or on approach of winter and in culture due to overcrowding or growth in continuous strong light. The akinetes had only a slightly thickened wall and were single or more usually composed of a row of cells (Fig 1). When put in tap water, even after three months the cells of the akinete (from both Nature and culture) began to elongate, thereby rupturing the wall which for a time remained attached to the end as H-pieces (Fig 2). The terminal cell gradually became acuminate and the basal cell acquired a hyaline mucous pad for attachment (Fig 3). Further growth and cell division resulted in a long filament.

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Origin of Viruses

IN recent times two abnormalities have arisen in the apple Lord Lambourne when this variety has been grafted on to certain other kinds: (1) where the branches and growth lack rigidity, so that the weight of even a few fruits pulls the branches almost vertically to the ground, (2) where the fruit only develops about a quarter of normal size. Thus when Lambourne has been grafted on to the variety Excelsior, Lambourne has developed non-rigid growth, and when grafted on to Redcoat Grieve it has developed the small-fruit abnormality. The same reactions have occurred in Lambourne when it has been grafted on to certain other kinds.

The behaviour of the abnormalities¹ suggests they are of the nature of viruses and that they have arisen directly by grafting, that is to say, by the invasion of the cells of one variety by the proteins of another. In some cases where the abnormalities have arisen three individuals have been grafted

together, therefore the possibility of all three taking part in the origin of the abnormalities cannot be ruled out

Recently, Darlington² has recalled the work of Salaman and Le Pelley³, who found the potato King Edward when grafted on to other varieties produces disease, and it seems probable that the Lord Lambourne abnormalities are of the same kind. These cases differ, however, in one respect. For in the potato, King Edward introduces something into the varieties with which it is grafted which is deleterious to them, whereas in the apple it is Lord Lambourne which alone has, so far, suffered from combinations with different varieties or stocks

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¹ Crane, M B, *The Grover*, 22, 53 (1944)

² Darlington, C D, *Nature*, 154, 166 (1944)

³ Salaman, R N, and Le Pelley, R H, *Proc Roy Soc*, B 106, 140 (1930)

Fluorescence in Ultra-Violet Light as a Test for the Presence of Leaf Roll Virus in Potato Tubers

On reading an article in the *School Science Review*¹, I recently became interested in the use of ultra-violet light as a possible means of detecting the virus responsible for potato leaf roll in the tubers of the plant

Tubers were collected (including 'setts' where possible) from leaf rolled plants during late July and early August, and at the same time tubers were taken from healthy plants of the same varieties. After being cleaned they were examined under ultra-violet light from a 230 v 125 amp 3-pin base bulb fitted with a Wood's glass filter supplied, through Mr. Brennan, representative of the General Electric Co in Belfast. Since no fluorescence was observed from the entire tubers—they assumed a light mauve colour, with the 'eyes' showing up as white areas—they were then cut transversely. The cut surfaces of the tubers from the leaf rolled plants then displayed varying amounts of fluorescence. This fluorescence was most marked in the 'setts', where it appeared to extend throughout the medulla (pith), but was more limited in its distribution in tubers of the present season's growth, where it appeared to be confined to the vascular bundles

In comparison, cut tubers from healthy plants showed a much lighter colour on the cut surfaces than on the 'skin', but there was no sign of fluorescence—merely a lighter shade of the mauve colour referred to above

Although the number of tubers examined was small, there appears to be every possibility that this test could be used with some degree of certainty in diagnosing the presence of the leaf roll virus in potato tubers, and the test has the advantage of being rapid. The cutting of the tubers can be carried out near the 'heel' end, and damage to the buds in the 'eyes' easily avoided

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¹ Campbell, D A, *School Sci Rev*, 25, 275

Wood-boring Insects in Beech Furniture

IN Mr A L Howard's recent article¹ on "Beech Tree" it is stated that "beech has been favourite wood with chair-makers for 200 years perhaps more. The higher class makers generally used beech for the frame. Many specimens of artistic design and clever craftsmen have been lost, as the beech framework used attacked by the *Lyctus* or *Xestobium* beetles, or by the framework rapidly turning to dust, and chairs breaking up"

Records of infestation of timbers by these insects have, however, shown that neither normally occurs in beech furniture. *Lyctus* powder-post beetle (family Lyctidae) attack partly and recently seasoned sapwood of certain hardwoods such as oak, ash, and walnut, in which the vessel diameter is sufficient to accommodate the ovipositor of the female and which the starch content of the wood is adequate for the nutrition of the larvæ. Neither of these conditions is fully fulfilled by beech, which is not liable to infestation by these insects

Beech is not immune to attack by *Xestobium rufovillosum*, the death-watch beetle (family Anobiidae), but this insect rarely occurs in furniture although well known for its powers of destruction in roofing and other structural timbers, chiefly oak, when conditions are favourable for its development

There are two insects, both belonging to the family Anobiidae, which sometimes do cause serious damage to beech timber—the common furniture beetle (*Anobium punctatum*), the most frequent cause of worm in old furniture, not only of beech but also many other woods, including walnut, and, commonly, *Ptilinus pectinicornis*, which also occurs in sycamore and willow. Of these, the common furniture beetle is by far the more important, in the course of repairs to valuable furniture such as that mentioned by Mr. Howard, the use of a suitable preservative treatment for woods susceptible to attack by this insect is advisable to prevent a recurrence of the trouble

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¹ *Nature* 154 492 (1944)

'Newton and His Portraits

I WRITE with reference to the note in *Nature* January 13, on portraits of Newton. We have in this College a portrait of Newton painted by He Cooke in 1669, the year in which he became Lucas professor. Newton was a benefactor of St Catharine's College, lending money to erect the new building that period, a loan which he later made a gift. I have no record of the circumstances in which the portrait was painted, but it shows him as a young man in a red gown with the open neck typical of later portrait by Kneller

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RESEARCH ITEMS

hæmoglobin and the Crush Syndrome

A common type of air-raid casualty is the person who has remained trapped for several hours with a limb crushed or compressed beneath debris. Such patients, after their release and admission to hospital, frequently develop a characteristic set of symptoms which has been called the 'crush syndrome'. The most striking features of this condition, apart from surgical shock, are the excretion of myohæmoglobin in the urine and the onset of severe renal failure, which often ends in death from uræmia. Bywaters and Popjak (*Surg Gynec Obst*, 75, 612, 1942) attempted to reproduce this condition in rabbits by perimortal crushing or compression of the leg muscles. They found that surgical shock ensued in man, but there was no myohæmoglobinuria and renal damage. The absence of myohæmoglobinuria is readily explained by the finding that rabbit's muscles contain practically no myohæmoglobin, and the results naturally suggested that the renal damage which occurs in man might in some way be caused by the renal excretion of myohæmoglobin. Bywaters and Stead (*Quart J Exp Physiol*, 33, 53, 1944) have investigated this possibility and they find that the intravenous injection of myohæmoglobin into normal rabbits (with alkaline urine) does not damage the kidney, but the injection into rabbits with acid urine or into rabbits after limb crushing does produce severe kidney damage which may be fatal. It seems that in the crush syndrome both myohæmoglobin and various acid breakdown-products are liberated from the crushed muscle, and the excretion of myohæmoglobin in acid urine is the main cause of the renal damage, though why myohæmoglobin should damage the kidney is not yet clear.

Pancreatic Extracts and Cell Growth *in vitro*

I. N. Davidson and C. Waymouth (*Quart J Exp Physiol*, 33, 19, 1944) have shown that a simple extract of pancreas (pancreatin) contains substances which influence the growth of chick heart fibroblasts *in vitro*. Two factors have so far been separated and they have been partially purified, but not completely so. One factor, which the authors consider to be leucithinase A, has a striking effect on the morphology of the cells in culture. Normal fibroblasts, when nourished with embryo extract, present the appearance of a loose network of elongated cells with small nuclei, under the influence of this pancreatic factor the appearance alters to one of closely packed polygonal cells with round nuclei. The second factor stimulates growth of the culture (as judged by the release of nucleoprotein phosphorus), and its action seems to be similar to that of embryo extract. This factor probably comprises polypeptides and certain breakdown products of nucleic acids, substances which may well serve as raw materials for nucleic acid synthesis. Trypsin and ribonuclease, though present in the crude extract, were absent from the fractions finally employed, and are therefore excluded.

The Lower Jaw of Stegocephalia

The Stegocephalia are generally regarded as the prehistoric order that most nearly approaches the modern Reptilia, and consequently in them one is most likely to find morphological relationships which will help in understanding the conditions met with in reptiles. A comprehensive and comparative

account of the lower jaw of the Stegocephalia is furnished by T. Nilsson (*Kungl. Svenska Vetensk. Akad. Handl.*, 21, 1944). The following homologies are suggested: the bone up to now regarded as the 'splenial' of the Stegocephalia is termed the pre-splenial, while that in the reptiles is probably the fusion of pre- and post-splenials; the posterior meckelian foramen is the posterior mylohyoid, the anterior meckelian is the anterior mylohyoid and the post-symphysial foramen is the lingual foramen of reptiles. Owing to the considerable amount of overlapping in the dermal bones their superficial outlines do not indicate accurately their extension at deeper levels. The foramina and canals in the bones of the jaw allow of an attempt at a restoration of the nerves and blood vessels, and on this certain new names of general application are proposed for them. In considering the veins it is suggested that there were in the head of the Stegocephalia a series of sinuses similar to those in many living reptiles and that these served for the exuviation of the head and possibly to frighten enemies.

Scottish Cephalopods

For a number of years the Fishery Board for Scotland collected marine fauna over the Scottish area, using this term in a wide sense, and the Cephalopoda in this collection, together with those of the Royal Scottish Museum, Millport Marine Biological Station and the University of Glasgow, form the basis for an account of this group by A. C. Stephen (*Trans. Roy. Soc. Edin.*, 61, Pt. 1, 1944). In all 47 species and one variety are dealt with, but some of these are not strictly Scottish although, occurring in adjacent waters, they might be found within the narrower limits at any time. None of them is a new species, but our knowledge of the areas of distribution of some of them has been considerably extended. There is evidence to show that an increase in the flow of the North Atlantic Drift has been responsible for the immigration of several forms in comparatively recent years. These species are mainly southern forms like *Ommatostrephes sagittatus* and *Stenoteuthis caroli*, on the other hand, *Rossia glaucopsis*, a northern form, appears to have become more rare.

Termites of New Zealand

J. M. KELSEY has given (*N. Z. J. Sci. and Tech.*, May 1944) an account of the termites known from New Zealand and their identification. It appears that there are only two species indigenous to the Dominion, namely, *Calotermes brouni* Frogg and *Stolotermes ruficeps* Brauer. In addition to these there are eight species of Australian termites that have been accidentally introduced at one time or another. Of the native species, *C. brouni* does extensive damage to wooden buildings, posts, poles and trees. Attempts are now being made to find an effective means for its control. The other species, namely, *S. ruficeps*, is invariably found in decaying timber and has not so far been found attacking buildings. Of the Australian species, three kinds belong to the family Rhinotermitidae and are members of the genus *Coptotermes*. Four species are members of the Calotermitidae, and of these three belong to the genus *Calotermes* and one to *Porotermes*. The Termitidae are represented by a single species of *Eutermes*. The paper gives detailed descriptions of the eight species referred to above, together with illustrations of the chief distinguishing characters that separate them.

Golgi Bodies

REALIZING that much of the extensive work that has been done on the Golgi elements is based upon empirical procedures because of the lack of knowledge of their chemical nature and composition, Dr J. R. Baker (*Quart J Micro Sci*, 85, Pt 1, 1944) has tackled the problem of their structure from a new point of view. For the purpose of this study the author took the spermatocytes and early spermatids of the snail *Helix aspersa*, intestinal cells from the newt *Triturus vulgaris* and cells from the anterior mesenteric ganglion of the rabbit *Oryctolagus cuniculus*, which he considered gave him a wide enough range of animals and tissues to allow generalizing. Structurally, it was found that the Golgi element consists of four parts, the 'neutral red vacuoles', a dense lipid containing substance in various shapes, a diffuse lipid-containing substance filling in the interstices and a Golgi product which arises in the vacuole by synthesis by the element. The first part of the paper consists of a description of the structures found, checked up where possible against the structures visible in the living cell. The second part is an account of the chemical nature of the structures and their reactions to various techniques.

Sex Determination in *Habrobracon*

P. W. WHITING (*J Hered*, 34, 355, 1943) has summarized the recent data on sex determination in the parasitic wasp *Habrobracon*. Formerly it was believed that the female was XY and the male haploid X or Y, or diploid XX or YY in respect to the sex determiners. It is now shown that sex determination is controlled by a series of multiple allelomorphs in such a way that the heterozygotes are female, and the haploids and homozygotes are male. Some rather novel results are obtained consequently in sex linkage and in the nature and occurrence of sex mosaics. Haploid mosaic males appear at a frequency between 1 in 500 and 1 in 5,000 in the progeny of heterozygous females. They arise from binucleate eggs. In a few cases trinucleate eggs must have been involved. Also females have arisen without fertilization as a result of doubling of the chromosome number in the oogonia. Dispermy is relatively frequent, but the expected androgenesis is rare. The sex reactions of the insect were known to be associated with the head, but it is now known that an insect with female eyes and male antennae reacts as a female, thus limiting considerably the tissues which are associated with sex reactions.

Plant Growth Substances

THE relation between molecular configuration and activity of plant growth substances or auxins has yet to be elucidated, but V. T. Stouzemeyer (*Proc Amer. Soc. Hort Sci*, 42, 365, 1943) reports that the addition of methyl, hydrogen and isoprene groups at various positions on naphthalene acetic acid does not reduce its root-forming properties. The addition of the isoprene group in some cases actually increased activity, while tetrahydronaphthalene acetic acid usually caused the production of a greater weight of roots per cutting (without increasing the number of cuttings rooted) than the unreduced acid. The same worker later reports that while naphthalene butyric acid is as effective as (and less toxic than) the corresponding acetic acid, and the isoprene ester of the naphthalene butyric acid is still more effective, α -naphthalene α -propionic and α -naphthalene β -propionic acid were both less effective than α -naphthalene acetic acid.

Effect of Methyl Cellulose on Water-loss in Plants

In a short note, I. M. Feller and V. R. Gard (*Proc Amer. Soc. Hort Sci*, 43, 183, 1943) describe an experiment the results of which may have far-reaching consequences. They show that the addition of a 1 per cent or 2 per cent aqueous suspension of methyl cellulose to bare soil or to soil in which plants were growing in a greenhouse reduced water loss from both soil and plant by as much as 50 per cent without exerting any observable harmful effects on the plants. Initial treatment remained effective for three months. If further experiments show that repeated treatments have no harmful effects on the soil or on plant growth, these experiments may prove to be of prime importance in at least a limited field of horticulture.

Polythene as a High-Frequency Dielectric

Prof. Willis Jackson and Mr. J. S. A. Forsyth recently read a paper on this subject in London before the Institution of Electrical Engineers. Their paper is mainly concerned with the power factor of polythene which, being normally of the order 0.00015-0.0003, renders the material very suitable as a high-frequency dielectric. Oxidation may occur, however, during the processing of the material in the manufacture of cables and mouldings, thus increasing the power factor and leads also to difficulties in extrusion. These effects may be virtually eliminated by the use of small amounts of antioxidants. The measurable power factor of pure polythene is scarcely concordant with the supposedly non-polar nature of the substance, and a number of possible explanations of the small basic power factor have been investigated. Measurements of power factor over a wide frequency and temperature range show that variation for pure polythene is extremely sluggish, but that oxidation causes the appearance of marked peaks; these observations are examined in the light of present theories of dipole loss. A brief account is given of the structure of polythene, and of its mechanical and physical properties.

Observations of Eros at the Cape Observatory

A PAPER on observations of Eros during 1938-1942, communicated by H. M. Astronomer at the Cape (*Mon. Not. Roy. Astro. Soc*, 104, 3, 1944), includes a short description of the instruments used and of the method of reduction of the plates, etc. In 1938 observations were made with the astrographic telescope west of the pier. In 1942 the first two or three exposures were generally made with the telescope west of the pier before Eros reached the meridian; then observations were made with the Victor telescope near the meridian. Finally, the astrographic telescope was reversed and several exposures were made with the telescope east of the pier. The same plate was used for the two sets of exposures with the astrographic telescope and hence the meridian of the two sets should eliminate any displacement due to tilt of the plate. The plates during 1938 were taken by Dr R. H. Stoy, and in 1942 they were generally taken by Dr J. Jackson. Tables with the results of the observations in the two years are given, but for 1938 the observed positions only are given, corrected for parallax and referred to the equinox of 1938. For 1942 an ephemeris by Stracke was available, for comparison with this ephemeris it is only necessary to subtract the light-time from the time of observation, corrections for parallax and aberration have been applied to the positions given.

EPIDEMIOLOGY OF BARTONELLOSIS

Any biologist requires a problem which will exercise to the full his patience and experimental skill, he could get it from the monograph "Infectious Anemias due to Bartonella and Related Cell Parasites", by David Weinman (*Trans. Amer. Phil. Soc.*, Philadelphia, New Series, 33, Part 3, 3-350, 1944). Weinman was parasitologist to the Harvard Expedition to Peru in 1937, which finally established the fact that *Bartonella bacilliformis* is the cause of both Oroya fever and Verruga peruviana (Verruga peruana), both of which are sometimes called Carrion's disease. Carrion, one of the pioneers of the study of these South American diseases, died of Oroya fever after inoculating himself with verruga material.

As Prof. Tyzzer says in his preface to this monograph, the symptoms of these two diseases are so different that it is not surprising that they were, until comparatively recently, considered to be due to different organisms. The main symptoms of Oroya fever are fever, marked pain in the head, joints and bones and a rapidly developing anaemia. If the patient does not die in a few weeks, a verrucous stage may follow. The mortality is 40 per cent or higher. Verruga peruviana is a milder infectious disease in which superficial and deep nodules appear. The superficial ones resemble warts and are about the size and colour of cranberries when they are mature, the subcutaneous ones are larger, less numerous and often erode the skin surface. These nodules last from one to twelve months and then disappear. Mortality is low. Latent infections with *Bartonella bacilliformis* may occur without symptoms. It is now known that both diseases are due to the single species of *Bartonella*—*Bartonella bacilliformis*—which was formerly classed among the Protozoa, but is now classified by Tyzzer, Weinman and others as a gellated bacillus.

The two diseases caused by this organism are both confined, at present, to a restricted area of South America, namely, to a narrow strip of the Andes in Peru to foci in the south-west of Ecuador and to the neighbourhood of the city of Pasto in Colombia. Central American foci in Honduras and Guatemala have been suspected, but have not been proved. Weinman points out, however, that human bartonellosis appears to be spreading in its epidemic form. In animals the related genera *Hemobartonella* and *Eperythrozoon*, which have been, for reasons discussed by Weinman in this monograph, removed from the genus *Bartonella*, are widely distributed and may be present in laboratory animals used for studies of the blood or reticulo-endothelial system or for nutritional and other problems, they may profoundly affect the results of these studies. The comparative study of animal bartonellosis may, Weinman thinks, illuminate the etiology, pathogenesis and treatment of blood diseases. This study has already revealed that the spleen has an important immunological function in animals infected with *Bartonella*. It maintains an equilibrium between certain of these parasites and their hosts, which is so perfect that infection may never be apparent unless splenectomy is performed, and the study of this function of the spleen may give us new information about the relation of the spleen to immunity. We are here reminded of the work of J. E. Larsh, jun. (*Amer. J. Hyg.*, 39, 133, 144, and *Trop. Dis. Bull.*, 41, 765; 1944) on the increased susceptibility of mice not infected with

Bartonella to infestations with the cestode *Hymenolepis nana* var. *fraterna*, when the whole spleen (that is, a large part of the reticulo-endothelial system) is removed.

Historically the cutaneous form of human bartonellosis, Verruga peruviana (Verruga peruana), was known to the pre-Inca inhabitants of Peru. Among the illustrations of operations and diseases found on ancient pottery ('huacos') "pertaining to the Chimu civilization", Verruga peruviana has been identified. When the Spaniards arrived, they found that Verruga peruviana was already distinguished in the Keshua language from the common wart and other diseases, and the very first group of conquering Spaniards suffered from it. Less appears to be known about the history of the anæmic form of human bartonellosis (Oroya fever). A serious epidemic of it in 1870 in workers building a railway from Lima to Oroya caused 7,000 deaths, and this and later epidemics led to the popular saying that "every cross-tie in the railroad represented a human life". The nature of Oroya fever was not clearly known until Carrion, who was dissatisfied with the existing knowledge of Verruga peruviana, decided to inoculate himself with verruga material. He developed Oroya fever and died of it on October 5, 1885. It was not until 1905 that Barton described bodies in the blood which were, he claimed, living organisms and the cause of Oroya fever. His claims were not accepted until the 1913 Harvard Expedition to Peru confirmed Barton's findings and gave the name *Bartonella bacilliformis* to the bodies which he had described. This Expedition made great contributions to our knowledge of the disease. But its etiology remained obscure until Noguchi and Battistini cultivated *B. bacilliformis*. The 1937 Harvard Expedition to Peru finally established the fact that *B. bacilliformis* causes both Oroya fever and Verruga peruviana.

B. bacilliformis is extremely polymorphous, and its taxonomy, microscopical appearance, cultivation and behaviour in experimental animals are fully described by Weinman. The symptoms of the various forms of the two diseases which it causes are also described in detail. The section on epidemiology and transmission by sandflies is valuable. *Phlebotomus verrucarum* seems to be the most important vector of the three species of *Phlebotomus* occurring in those areas of Peru in which bartonellosis is endemic (*P. verrucarum*, *P. noguchii*, *P. peruensis*). The four other Peruvian species of *Phlebotomus* have not yet been incriminated, and no other blood-sucking arthropod has been shown to be naturally infected with *Bartonella*. Infection by contact does not occur in ordinary circumstances. The disease has, however, been reported as a new one in Colombia since 1935, and none of the Peruvian sandflies has yet been collected in Colombia. This suggests that *B. bacilliformis* was introduced into Colombia and then became established in the Colombian sandflies, rather than that Peruvian infected sandflies became acclimatized in Colombia (as, for example, African *Anopheles gambiae* became established in Brazil in 1939 and caused there one of the most devastating epidemics of malaria known to history (see *Nature*, 153, 765, May 20, 1944)). If this is so, the question arises whether other species of *Phlebotomus* could become vectors of *B. bacilliformis*. This question has not been studied experimentally. It is important, because sandflies which bite man are widely distributed throughout the world in tropical and temperate countries (cf. the part they play in transmitting to

man the cause of human cutaneous leishmaniasis (*Leishmania tropica*) in the Gerbils and Sousliks of the deserts of middle Asia, described in a review of Russian work on this question by C. A. Hoare (*Trop. Dis. Bull.*, 41, 331, 1944). Modern rapid methods of transport could either carry the sandflies which transmit *Bartonella* or infected human beings to an area inhabited by uninfected sandflies.

Two alleged cases of congenital transmission of *Bartonella* in man are reported by Weinman, and the factors affecting susceptibility and resistance to the infection are discussed. Man is the only important known source of *B. bacilliformis*, and *Phlebotomus* the only other animal known to be naturally infected. There is, however, some evidence that dogs may be naturally infected sometimes. The suggestion that domestic animals, lizards, rats and some plants may be reservoirs of the infection has not been confirmed. Weinman discusses at length the immunology, treatment and control of the infection, but these complex questions cannot be discussed here. Treatment of Oroya fever is the most important, because of its high mortality, but the study of it is handicapped by our inability to produce the syndrome at will in experimental animals.

In Chapter 2 Weinman discusses the genus *Hæmobartonella*, created by Tyzzer and Weinman in 1939, to include *Bartonella*-like organisms which do not multiply outside the blood and do not produce skin eruptions, whereas human *B. bacilliformis* develops in fixed tissue cells and causes skin eruptions. *H. muris*, the type species, is a widely distributed parasite of the albino rat, in which it exists as a latent infection and causes anemia. It is transmitted by rat lice and fleas. It is infectious for albino mice, the rabbit and some other rodents. It can be eradicated by neoarsphenamine and other organic arsenicals. Weinman describes fully the other species, of which twenty-one have been named. Those most clearly established are in albino rats and mice and some other rodents, in voles, guinea pigs, oxen, buffalo and dogs. Other forms of *Hæmobartonella* not of specific rank have been found in the wild rat, dormouse, opossum, hamster, deermouse and squirrel. Organisms having some resemblance to *Hæmobartonella* have been recorded from the bat, monkey, ant-eater, rat and dormouse and from the tortoise, frog, lizard, gecko, lamprey, tench and pike.

Chapter 3 deals with *Eperythrozoon*. Species of this genus are blood parasites with some resemblance to *Bartonella* and *Hæmobartonella*, and they cause anemia in various vertebrates. The infection, which at first causes symptoms, becomes latent, and removal of the spleen causes relapses. These organisms have not yet been cultivated *in vitro*, but animals can be infected by inoculation of infected blood. Their transmission by arthropods is known and they respond to therapy with organic arsenicals, so that they are regarded as being living organisms. They occur in white mice (*E. coccoides*, transmitted by the louse, *Polyplocus serrata*, and possibly by other means), in dwarf mice and voles (*E. dispar*), in sheep (*E. ovis*, the method of transmission is not known) and in cattle (*E. wenyonii*, the method of transmission is not known). Other so-called species require confirmation. The single case in which infection of man (a child) with *Eperythrozoon* was suspected is discussed by Weinman.

Chapter 4 discusses the public health aspects of bartonellosis. Its importance is shown by the fact that although the epidemic of 1870 in Peru involved

a very small region, some 7,000 people died, and in Colombia more recently 4,000 deaths have been attributed to bartonellosis in one year (1938). The disease is, so far as we know, restricted to Peru, Colombia and Ecuador, and is irregularly distributed in a long, narrow area of the Andes, 1,000 miles long by about 100 miles wide, in which it occurs at moderate altitudes, near water and most often in narrow valleys, but it is probable that its distribution is incompletely known.

Man is both the victim and reservoir of *Bartonella bacilliformis* and no other animal naturally infected with this species is known, except the sandfly vector. Weinman discusses fully the epidemiological evidence for this. Further knowledge of the insect vector is required, because most of our knowledge about it has been worked out in Peru only. The nocturnal biting activity of the sandfly explains why the disease is chiefly contracted at night, and this biological fact has been used for control. Workmen repairing a railway bridge over the Rimac River, for example, removed by train from the bridge in time to be outside the endemic zone before nightfall. *Phlebotomus*-proof buildings would be equally effective, and when Shannon lived for months in one of these in an endemic area, he did not become infected, but the expense of providing them for everyone would be great. Repellents applied to the body and insecticides are said to help protection. Other measures aim at reduction of the numbers of the sandflies by destruction of the day-time hiding places of the adults in dark places, but lack of knowledge of the biology of the immature stage handicaps this kind of control. The adults are not vigorous fliers and probably do not get very far from the places where they emerge. The fact that endemic foci of the disease are bounded by upper and lower limits of altitude, which are often quite sharply defined, requires further explanation.

G. LAPAGE

SCIENTIFIC AND INDUSTRIAL RESEARCH IN NEW ZEALAND

THE eighteenth annual report of the Department of Scientific and Industrial Research, New Zealand, covering the year 1943-44, includes the Minister's statement, the Secretary's report, reports of the research committees of the Council, and of research work at the Canterbury and Massey Agricultural Colleges, as well as on the Dominion Laboratory, Observatory, Physical Laboratory, Magnetic Observatory, Geological Survey and Meteorological Branch.

Under the Building Research Committee, investigations have been continued by the Entomology Division of the Plant Research Bureau into the biology of the two native termites, and in co-operation with the Plant Diseases Division investigations were undertaken into the biology of *Anodium punctatum*, including the factors controlling oviposition and the influence of seasoning of both kiln- and air-dried sapwood against attack, with the view of securing data on the best method of treating various timbers as a protection against borer attack. The State Advances Corporation has continued its work on field investigations of timber-infesting insects and fungi, and field application of termite control and

1 preservatives A special committee was set up to deal with the problem of mould growth on the walls of houses, the report of the Plant Diseases Commission shows that mould growth can be controlled by applying a 2 per cent solution of the sodium salt of 2,4-dichlorophenol to the materials used in finishing wall surfaces The Auckland Building Research Institute has investigated the behaviour under stress of concrete consisting of pre-cast reinforced concrete slabs and slabs.

The Dairy Research Institute has again limited its research to projects concerned with the New Zealand effort, but has continued to give advice and assistance with the commercial manufacture of dry cream-fat by the method developed at the Institute. Work on land cress taint in cream and butter has clearly indicated that the benzyl isothiocyanate present in land cress is not the cause of the peculiar taint in the butter from cows consuming it, as garden cress contains the same glycoside Principles laid down in the previous year for the protection of starter culture from infection with bacteriophage have proved sound, and many isolated starter rooms have been built during the year at commercial cheese factories Continued experience has shown that low-strain starter cultures can be maintained free from infection over long periods where isolation together with aseptic handling is practised A tentative start has been made on an investigation into the possible use of phage as a cure for mastitis in dairy cows Some progress has been made in the field towards a cure for 'mechanical' openness in cheese. More studies have covered milk secretion in dairy cows and parturition in pigs.

Under the Food Preservation and Transport Advisory Committee, development work has continued on dehydrated meat, including the increase of fat content to 40 per cent by addition of edible rendered tallow, and the installation of plant for the production of the concentrated cooking juices to improve flavour and compatibility, and for packaging dried meat under compression in accordance with specifications of the United Kingdom Ministry of Food. Commercial manufacture of dehydrated vegetables began at the end of March 1943, in a small dehydrator of the Eidt type designed by the Mechanical Engineering Section of the Dominion Laboratory, the plant has given performance and quality fully up to expectation Dehydration of apples on behalf of the Internal Marketing Division has now reached the production stage Fruit cold-storage research has included the refrigerated gas storage of apples, superficial scald on Granny Smith apples, the effect of fertilizers at the root on cold-storage quality and the control of wilt in cold-stored apples and apples Under the Fruit Research Advisory Committee, long-term manurial investigations and stock trials on apples have continued and other work has covered stone fruit and citrus Research at Cawthron Institute has covered the magnesium deficiency of apples, distribution of magnesium and potassium in leader growth and apple-juice concentration.

In the Industrial Psychology Division established towards the end of 1942, investigations have been in progress on absenteeism in forty-six factories in the main centres of the Dominion, on the ventilation and heating of factory buildings, and on the reduction of fatigue and monotony, especially the effect of dry seating The Division has also been responsible for the issue of a quarterly bulletin, lectures and

addresses, service work for manufacturing concerns, co-operation with the Government Vocational Guidance Centres and work for the Armed Services Under the Leather and Shoe Research Advisory Committee, the Leather Research Association has continued its work on the formulation of standards for sole leather, the flexibility of sole leather and a field trial to determine whether any relation could be established between wet rigidity and actual wearing value The Shoe Research Association has investigated the effect of the method of construction on the flexibility of the shoe with the object of linking the work up with that on the flexibility of sole leather Pelt research is yielding concrete results due to the institution of chemical controls in the process and the checking of the curing process in the finished pickled pelts

Investigations at the Cawthron Institute on the mineral content of pasture have covered the effectiveness of application of cobalt sulphate in field trials Under the Mineral Resources Committee, the prospecting and boring of the Clarendon phosphate deposits has been directed, and the results of the quantitative surveys of the Chatham Island peat wax deposits, with chemical work at the Dominion Laboratory and the Imperial Institute, have been published

The New Zealand Wool Manufacturers' Research Association has continued its work on improvements to the wet chlorination process of rendering woollen fabrics resistant to shrinkage The Plant Chemistry Laboratory has continued its research on the suitability of different varieties of vegetables for dehydration, and satisfactory results have now been obtained in dehydrating peas and beans Under the Plant Research Bureau, work on linen flax has included the production of pure seed and weed control, and the Botany Division has also continued weed investigations, work on fibre plants and on medicinal plants Investigations on the Russian dandelion indicate that a solution of the difficulties involved in direct sowing is crucial to development The Entomology Division has continued its survey of the diamond-back moth, cocksfoot stem-borer, and cheese-mites, and has found that dichloroethyl ether is highly toxic to the common cheese-mite, even at very low concentrations The Grasslands Division has maintained its plant-breeding programme with perennial rye grass, Italian rye grass, short-rotation rye grass, Western Wolds rye grass, cocksfoot, timothy, white clover and red clover, and there has been no slackening of the work on aerodrome grassing and turf Work on green-keeping research has continued, and plant disease investigations under the Plant Diseases Division have covered linen flax diseases, legume diseases, vegetable diseases and diseases of medicinal plants The Soil Survey Division has devoted attention to soil fertility problems and produced maps showing where this is being reduced through erosion Tobacco research has included fertilizer experiments, investigations on mosaic and other tobacco diseases, seed production and plant breeding, the chemistry of curing and recovery of nicotine from waste tobacco Research work at the Canterbury Agricultural College has included sheep-dipping experiments, investigations on insect pests of wheat crops, and wool survey by the Wool Metrological Laboratory, while at the Massey Agricultural College sheep-nutrition experiments, drainage research work and work on sheep-breeding methods and pig research have been in

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progress. Root development work, which has now been suspended, is reviewed in the report.

In addition to testing work the Dominion Laboratory has been concerned with research work, the Chemical Engineering Section being largely occupied with work connected with the dehydration of vegetables and apples, while the Physical Chemistry Section has been concerned mainly with spectrographic analysis. The Coal Survey Laboratory has continued its physical and chemical survey of the coal resources of the Dominion. Many investigations on paints and protective coatings have been carried out during the year both for defence and civilian purposes. Rubber problems investigated during the year included particle-size and other determinations of rubber fillers, preparation of rubber solutions, investigation of rubber tyre preservatives, rubberware for milking machines, and an examination of the possibility of manufacturing synthetic rubber in New Zealand. At the Dominion Physical Laboratory, the physical testing and electrical laboratory was concerned with the yield and quality of linen flax fibre, dimensional changes of trace line paper for map reproduction, mould on inner wall surfaces in New Zealand houses and the application of radioactive luminous paint for equipment.

At the Magnetic Observatory, Christchurch, the programme of work in terrestrial magnetism, seismology, cosmic radiation, atmospheric electricity and meteorology was generally maintained during the year.

BATS

By OLIVER G. PIKE

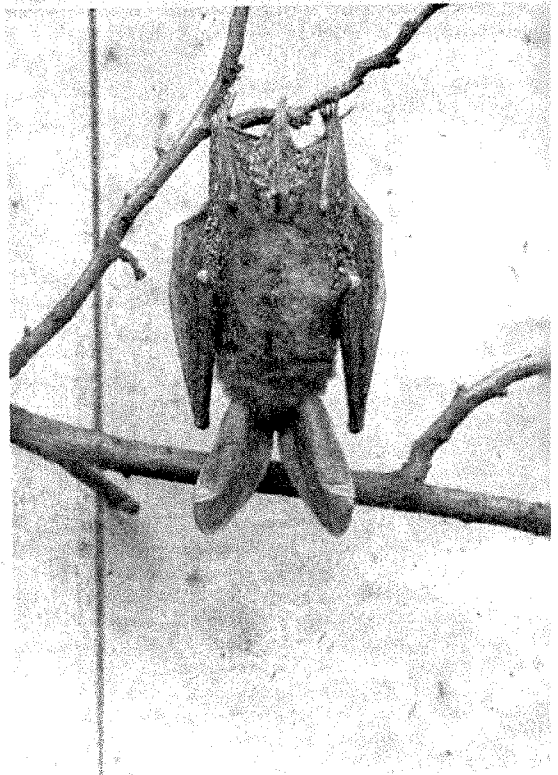
THERE are very few naturalists who can with certainty distinguish British bats in flight. It even comes as a surprise to many to learn that there are twelve species in Great Britain. The chief reason British bats have been so neglected is that they appear, except at rare intervals, at dusk and before dawn, and are therefore very difficult to observe. Apart from this, they live, as a rule, in rather inaccessible places, and most of their daylight haunts are dark.

When watching a bat on the wing, we are looking upon the most perfect example of flight. I do not know any bird that can equal their powers of manoeuvring; a bat going full speed (and it can travel fast) will suddenly stop, do a quick right or left turn, rise and dive, turn completely over, and perform other stunts that are bewildering to watch.

To many, bats are mammals without a voice. This is because the high-pitched cry, which is very frequently uttered while flying, is beyond the powers of hearing of about three out of every four people, while the low, loud noises, such as the beating of a large gong, make no impression on them.

Bats are flying mammals; through the millions of years of evolution their arms have changed into wings. If we examine the wing of a bat, we see how the bones are really exaggerated fingers, with a thin flexible skin stretched over them, while on the bone that corresponds with our thumb there is a hook, which the animal uses to attach itself to some support while resting.

All bats have one young only during the year, which is born in mid-summer; they are helpless at birth, and for several days are carried around by the



THE LONG-EARED BAT.

mothers while they search for their own food. When too heavy to carry, they remain in their haunt until about seven weeks old; then they are able to fly and search for food on their own account.

It is doubtful if the bat ever uses its eyes when searching for insect food; experiments have shown that bats which have been blindfolded and liberated in a room in which several strings were hung from the ceiling were able to avoid them with the greatest ease. To make up for the lack of sight, they seem to be provided with a sense of which we know little and to which it is difficult to give a name, but which appears to be connected with the 'earlet' of the species in the family Vespertilionidae, and the very remarkable facial development known as the 'hoof shoe' on the two species in the family Rhinolophidae. These organs, combined with their keen sense of hearing, assist them to dodge all obstructions, and to find insect food while flying in the dark.

Bats are the only surviving back-boned animals with the exception of the great class of birds, but they are able to fly, unlike the birds, they are rather helpless except while in the air.

There is a vast field open for the enthusiastic naturalist who cares to undertake the serious, difficult, study of these nocturnal mammals.

Some excellent work has been done in this respect by Mr. Brian Vesey-Fitzgerald, editor of the *Fauna*. In the *Proceedings of the Hampshire Field Club*, Part 1, pp. 64-71, he gives a detailed and valuable description of each of the twelve species found in the county, together with their distribution, founded upon his personal observations.

If naturalists in other counties would follow in his steps, we should gather a deal of valuable information about these much-neglected mammals.

KED-FLIES

THE ked-flies are blood-sucking Diptera, ectoparasitic on certain of the ruminant artiodactyls. These species occur on domesticated sheep and goats, they are of veterinary significance though not yet incriminated of acting as vectors of actual disease, occasionally they bite man. Information about these flies has been somewhat scattered, and a recent monograph¹ of the group by Prof J Bequaert of Harvard, accordingly, very welcome. Prof Bequaert has already published many shorter papers on the Hippoboscidae, of which the Melophaginae or ked-flies are a sub-family, his monograph of the ked-flies is thus the outcome of prolonged study.

The ked-flies show many interesting adaptations to their ectoparasitic mode of life. They are tough, athery, compact and somewhat flattened creatures. All are viviparous, producing larvæ that are fully developed and ready to pupate one at a time. The male reproductive organs are much modified, in a manner very similar to that of the tsetse flies (*Hossina*), for the retention of the larva and its nourishment.

The Melophaginae comprise four genera, *Neolipoptena*, *Lipoptena*, *Echestypus* and *Melophagus*. Species of the first three genera occur on a variety of goats, antelopes, deer, etc. They are all winged on emergence from the puparium, but the wings are cast when the flies have reached a suitable host. The mature larvæ, on being extruded by the females, apparently fall from the hairy pelts of their hosts and pupate on the ground. The only British representative of this group is *Lipoptena cervi* L., the ked of the red deer².

The genus *Melophagus* contains only two species. One of these, *Melophagus ovinus* Linnaeus, the sheep ked, is common in the British Isles². This species is now widespread, having been transported on its principal host, the domestic sheep. It does not, however, survive in all climates. Other hosts from which it has been recorded are the Marco Polo sheep and the Alaskan mountain sheep, but Bequaert¹ states that the ectoparasites of these two sheep have never been properly investigated and that the records are dubious. The other species, *Melophagus rupicaprinus* Rondani, occurs on the chamois. The adults of *Melophagus* are completely wingless. In the case of the sheep ked the larvæ do not normally fall to the ground but pupate in the fleece of the host and tick there. Powers of flight are thus not required by the adult when it emerges from the puparium. Nothing is known of the life-history of the chamois ked but, as Bequaert points out, the chamois has an undercoat of short wool beneath the visible pelt of longer hairs.

Bequaert discusses the probable evolution of the Melophaginae. He considers that the family Hippoboscidae appeared in the Cretaceous and that they are originally all ectoparasites of birds. He thinks that the passage from birds to the artiodactyls took place when the latter began to arise in the Lower Cretaceous. There are no fossil Hippoboscidae but, taking the family as a whole, 65 per cent of the recognized genera and 88 per cent of the recognized species of recent Hippoboscidae are parasitic on birds. Furthermore, no recent Hippoboscidae have small mammals as their hosts, and at the time when the Hippoboscidae appear to have arisen (late Mesozoic) there was a variety of birds but only small mammals. The plumage of any bird offers good protection to larger ectoparasites like the Hippoboscidae, while

smaller mammals can usually kill larger ectoparasites in the pelt.

It would seem that the fate of recent Melophaginae is intimately linked up with the fate of the artiodactyls, since they have left the birds and have become highly specialized for an ectoparasitic existence on these mammals. This order of mammals has a great past in the Oligocene and the Pliocene, but it is now on the wane. Bequaert suggests that the Melophaginae may disappear within the next century should the present decline of their wild hosts continue, efficient insecticides may cause the species on the domestic sheep to suffer a like eclipse.

A century hence, naturalists may be consulting Prof Bequaert's monograph for information about an extinct sub-family of the Diptera.

JOHN SMART.

¹ Bequaert, J., "A Monograph of the Melophaginae, or Ked-Flies, of Sheep, Goats, Deer and Antelopes (Diptera, Hippoboscidae)" *Entomologica Americana*, 22, 1 (1942).

² Edwards, F. W., Oldroyd, H., and Smart, J., "British Blood Sucking Flies", 118 (1939).

THE INDIAN FAUNA DURING 1942-43

AN interesting tabular statement is given in the *Indian Forester* (70, No 4, April 1944) Civil and Military Gazette Ltd, (Lahore) of the animals shot in some of the Indian Provinces and States during 1942-43. Of British India, only Madras appears to have sent in no figures. The Indian States are confined to Jammu and Kashmir.

The protection of some of the species which two score years ago were in grave danger of becoming extinct has to some extent been safeguarded through the advent of the game sanctuary. Rhinoceros was one of the animals threatened. During 1942-43, only two rhinoceroses were killed in the whole of India, in the province of Assam. Of gaur or bison, 25 only (Madras sent in no returns, unfortunately) were shot, the greater number in the Bombay Presidency (9) and the Central Provinces (8), while none of its close relative the goyal or mithan was killed, nor any banting or tsine. Of wild buffalo, another animal the numbers of which were seriously decreasing, only four were shot in Assam. Wild elephants, killed in British India at least, do not really afford much light on the numbers extant in the different provinces, for the individual public are only allowed to shoot or trap any animal specially proscribed as dangerous or, in the second case, with a special permit from Government. Thirty-two are shown to have been shot in the several provinces, there is a footnote to the statement, however, which says that a few sambar, barking deer and wild elephants—a curious assemblage—were killed by military units in Chittagong District, Bengal.

Turning to the Carnivora, a total of 219 tiger, and tigresses were shot, the greater number in the Central Provinces and Berar (65), and the United Provinces (91); of leopard or panther 173 were shot, the United Provinces again heading the list of kills with 54, the Central Provinces 44, and Bombay Presidency 32, the hunting leopard or cheetah is confined, so far as animals shot are concerned, to Coorg (31), and Jammu and Kashmir (15), a curious record in distribution of the animal possibly due to incorrect diagnosis. The records of wild dog (28 shot only) are

disquieting when the ravages among the deer tribe it is capable of committing are remembered, and of the wolf, 1 shot in Sind and 34 in Jammu and Kashmir are zoologically of interest

The bears, for several reasons connected with their varied and wide distribution, are, from the 1942-43 record, curious. Of the brown bear, only three were shot, Himalayan black bear 64, of which 51 were in Jammu and Kashmir. Malayan bear, for perhaps obvious reasons so far as British records go, nil, sloth bear 28, of which 16 were in Jammu and Kashmir and 8 in the Central Provinces. Of the deer tribe, 255 sambar were shot (C.P. 84, U.P. 75, and Bengal 26), and cheetal or spotted deer 291 (U.P. 177, C.P. 78, and Bengal 24).

Turning now to the Himalayan fauna, only 4 urial or sharpu were shot, 1 bharaal or blue sheep, 7 ibex (Kashmir) and 2 markhor, 5 tahr, no serow, which is curious, and only 10 goral. Of the common little black buck of the plains, the return shows only three shot.

This return for 1942-43 is of some interest and value since it appears to indicate that the large increase in the fighting forces in India has not synchronized with a far heavier mortality in wild animals, as might have been anticipated.

FORTHCOMING EVENTS

Saturday, January 27

ASSOCIATION FOR SCIENTIFIC PHOTOGRAPHY (at Caxton Hall, Westminster, London, S.W. 1), at 2.30 p.m.—Mr H. K. Bourne "Electric Discharge Lamps for Photography"

Monday, January 29

ROYAL GEOGRAPHICAL SOCIETY (at Kensington Gore, London, S.W. 7), at 5 p.m.—Mr W. H. Ward "The Stability of Natural Slopes"

Tuesday, January 30

ROYAL ANTHROPOLOGICAL INSTITUTE (at the Imperial Institute, Exhibition Road, South Kensington, London, S.W. 7), at 1.30 p.m.—Mrs Bertild Bekker "Ma-Maroh" (Devil-Feast)

INSTITUTION OF BRITISH AGRICULTURAL ENGINEERS (at the Institution of Electrical Engineers, Savoy Place, Victoria Embankment, London, W.C. 2), at 2 p.m.—Mr T. A. Wedderspoon "Soil Cultivation" (supporting Intensive Cultivation), Dr E. W. Russell "Soil Cultivation" (supporting the Minimum of Cultivation)

ROYAL INSTITUTION (at 21 Albemarle Street, London, W. 1), at 5.15 p.m.—Prof F. Wallace "The Diagnosis of Mineral Deficiencies in Crop Plants", (1) "Visible Symptoms produced by Mineral Deficiencies"

SHEFFIELD METALLURGICAL ASSOCIATION (at the Royal Victoria Station Hotel, Sheffield), at 6.30 p.m.—Sir Alexander Dunbar "The Future of the Steel Industry"

Wednesday, January 31

ROYAL SOCIETY OF ARTS (at John Adam Street, Adelphi, London, W.C. 2), at 1.45 p.m.—Mr G. Pierce Clingan "National Building Regulations"

SOCIETY OF CHEMICAL INDUSTRY (MICROBIOLOGICAL PANEL OF THE FOOD GROUP) (at the Chemical Society, Burlington House, Piccadilly, London, W. 1), at 2.15 p.m.—Dr T. F. West and Mr G. A. Campbell "The Story of D.D.T. and its Role in Anti-Pest Measures"

INSTITUTE OF WELDING (at the Institution of Civil Engineers, Great George Street, Westminster, London, S.W. 1), at 6 p.m.—Discussion on "Welding in Higher Technical Education" (to be opened by Prof H. Wright Baker and Mr H. Martin)

Thursday, February 1

INSTITUTE OF FUEL (at the Institution of Mechanical Engineers, Storey's Gate, St. James's Park, London, S.W. 1), at 2.30 p.m.—Mr P. M. K. Embling "The Gasification of Bituminous Coal in Producers"

ROYAL INSTITUTION (at 21 Albemarle Street, London, W. 1), at 5.15 p.m.—Prof James Gray F.R.S. "Locomotor Mechanisms in Vertebrate Animals", (1) "Swimming of Dolphins, Gliding and other Types of Movement in Snakes"

INSTITUTION OF ELECTRICAL ENGINEERS (joint meeting with the INDUSTRIAL RADIOLOGY GROUP OF THE INSTITUTE OF PHYSICS) (at Savoy Place, Victoria Embankment, London, W.C. 2), at 5.30 p.m.—Mr V. E. Pullin "A Survey of X-Rays in Engineering and Industry"

Friday, February 2

ROYAL INSTITUTION (at 21 Albemarle Street, London, W. 1), 5 p.m.—Prof E. N. da C. Andrade, F.R.S. "Metal Crystals and Crystal Strength"

SOCIETY OF CHEMICAL INDUSTRY (joint meeting of the PLASTIC GROUP with the MANCHESTER SECTION OF THE S.C.I.) (at the Grosvenor Hotel, Aytoun Street, Manchester, M. 1), at 6 p.m.—Dr W. J. S. Nuttall "The Influence of Auxiliary Chemicals on the Past and Future Development of Synthetic Rubber"

Saturday, February 3

BIOCHEMICAL SOCIETY (at the British Post-Graduate Medical School, Ducane Road, Shepherd's Bush, London, W. 12), at 11 a.m.

APPOINTMENTS VACANT

APPLICATIONS are invited for the following appointments on or before the dates mentioned

DEPUTY BOROUGH ELECTRICAL ENGINEER AND MANAGER, Corporation of Barking—The Ministry of Labour and National Service, Central (T and S) Register, Room 5/17, Sardinia Street, Kingsway, London, W.C. 2 (quoting Reference No. D 1048 XA) (January 31)

DEPUTY BOROUGH ELECTRICAL ENGINEER, Borough of Royal Tunbridge Wells—The Ministry of Labour and National Service, Appointments Dept. A3(B), Room 5/17, Sardinia Street, Kingsway, London, W.C. 2 (quoting Reference No. D 1042 XA) (January 31)

ASSISTANT ENGINEER by the Government of the Tanganika Territory—The Ministry of Labour and National Service, Appointments Department A3(B), Room 5/17, Sardinia Street, Kingsway, London, W.C. 2 (quoting Reference No. E 1149 A) (February 2)

MECHANICAL MAINTENANCE ENGINEER in the Swansea Electric Department—The Borough Electrical Engineer and Manager, Guhall, Swansea (February 3)

ASSISTANT IN THE DEPARTMENT OF ECONOMICS for the Farm Management Survey Scheme—The Acting Principal, South-Eastern Agricultural College, Wye, Ashford, Kent (February 3)

LECTURER (full-time) IN MATHEMATICS in the Science Department, The Clerk to the Governors, South-East Essex Technical College, School of Art, Longbridge Road, Dagenham (February 3)

LECTURER (full-time) with special responsibility for ELECTRICAL ENGINEERING in the Bolton Municipal Technical College—The Director of Education, Education Offices, Bolton Lanes (February 5)

METALLURGIST for works in South Midlands on essential war work and with post-war interests in mass production of refrigerating domestic equipment, etc.—The Ministry of Labour and National Service, Appointments Department A3(B), Room 5/17, Sardinia Street, Kingsway, London, W.C. 2 (quoting Reference No. F 3386 2) (February 6)

GENERAL MANAGER AND ENGINEER OF THE STOCKTON-ON-TYNE ELECTRICITY DEPARTMENT—The Town Clerk, Barclays Bank Chambers, Stockton-on-Tees (endorsed "Electricity General Manager and Engineer") (February 7)

QUALIFIED METALLURGIST for large Iron Foundry by old-established Engineers in East Midlands manufacturing specialized machinery—The Ministry of Labour and National Service, Appointments Department A3(B), Room 5/17, Sardinia Street, Kingsway, London, W.C. 2 (quoting Reference No. F 3127 XA) (February 8)

TECHNICAL LIBRARIAN (female) by small works located in London—The Ministry of Labour and National Service, Central Register, Room 5/17, Sardinia Street, Kingsway, London, W.C. 2 (quoting Reference No. A 770 XA) (February 9)

SPEECH THERAPIST—The Director of Education, Education Office 15 John Street, Sunderland (February 12)

LECTURER IN ELECTRICAL ENGINEERING SUBJECTS, and a TEACHER OF GENERAL SCIENCE, in the Ipswich School of Technology—Chief Education Officer, Education Department, 17 Tower Street, Ipswich (February 16)

UNIVERSITY READERSHIP IN LOGIC AND SCIENTIFIC METHOD, available at the London School of Economics and Political Science—Academic Registrar, University of London, c/o Richmond College, Richmond, Surrey (February 26)

PSYCHOLOGIST to the Essex Education Committee—The Chief Education Officer, County Offices, Chelmsford (February 28)

UNIVERSITY CHAIR OF CIVIL AND MECHANICAL ENGINEERING, available at Queen Mary College—The Academic Registrar, University of London, c/o Richmond College, Richmond, Surrey (March 1)

ASSISTANT SECRETARY jointly to the Glass Delagacy of the University of Sheffield and to the Society of Glass Technology—The Registrar, The University, Sheffield

GRADUATE TEACHER OF GENERAL SCIENCE in the Burton-upon-Trent Technical Institute and Junior Technical School—The Secretary and Director of Education, Education Offices, Guild Street, Burton-upon-Trent

ASSISTANT MASTER to teach MECHANICAL ENGINEERING SUBJECTS—The Principal, Technical College, Wolverton, Bucks

LABORATORY ASSISTANT (skilled) for PHYSIOLOGY DEPARTMENT—The Vice-Dean, St. Bartholomew's Hospital Medical College, Queen's College, Cambridge

REPORTS and other PUBLICATION

(not included in the monthly Books Supplement)

Royal Meteorological Society. Bibliography of Meteorological Literature Prepared by the Royal Meteorological Society with collaboration of the Meteorological Office Vol. 5, No. 6 (July-December 1943), No. 7 (January-June 1944) Pp. ii+97-152 (London: Royal Meteorological Society, 1944) 5s

NATURE

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THE MORAL BASIS OF WORLD ORDER

ALTHOUGH, as was stated by Lord Cranborne in the House of Lords on December 19, the Government is not yet committed to the acceptance of the Dumbarton Oaks proposals for the establishment of a general international organization, those proposals must inevitably form the measure or yardstick against which other proposals will henceforth be judged. Such discussion will be facilitated by the commentary on the proposals which the Government issued in November (Miscellaneous No 6 [1944]. Cmd 6571. H.M. Stationery Office, 1944, 2d net). It should be stimulated by the unhappy developments in Greece and in Polish-U.S.S.R. relations, with all the evidence provided thereby of the necessity of a moral basis and of a common standard, not merely of cultural ideals, but also of public conduct, to enable any form of international organization to function.

That was the theme of the debate opened in the House of Lords on December 19, on a motion of Viscount Templewood, urging the strengthening of the unifying forces of Europe by ensuring to every European citizen the fundamental rights and liberties without which European civilization cannot continue. Whether or not we accept the precise proposals of Lord Templewood, which bore some resemblance to the Declaration of the Rights of Man of which Mr H. G. Wells gave a first draft in his "New World Order", and which some five years ago were discussed with the view of formulating a charter embodying the principles of liberty of thought and freedom from frustration by authority, there can be little doubt that the provision of effective guarantees is, as Lord Cranborne said, a great practical difficulty. It is one thing for nations voluntarily to pledge themselves to maintain and observe certain rights, it is quite another thing to impose the observance of those rights on them by force.

As Lord Cranborne reminded the House of Lords, and as is stressed in the Commentary on the Dumbarton Oaks proposals, under Chapter 9, the organization is concerned with promoting respect for human rights and fundamental freedoms, responsibility for which is vested in the General Assembly and, under the authority of that body, in an Economic and Social Council. The methods by which such objectives are to be achieved are left to those bodies to determine, and clearly the questions referred to by Lord Templewood and others in the debate must be fully explored. At least it may be urged that if the fundamental problem is that of securing the re-acceptance in Europe—and in the world at large—of a common moral standard, that acceptance must be by consent and not by force.

The fundamental method must be education, and while the sombre picture of Europe painted in this debate left no doubt as to the formidable nature of that task, there was a welcome reminder of the spiritual forces on which we can call for aid. The Bishop of Chichester urged that the common culture of Europe is based on four common spiritual traditions: the

humanist, which is largely responsible for the liberal and humanitarian element in our civilization, the scientific tradition, the clearest example of the part played by individual collaboration in European culture, the tradition of law and government, and the Christian tradition. The last, he urged, is the most important, and potentially is capable of unifying the four. Referring to the spiritual quality of the resistance movements and the natural bond existing between patriotic men in the Church and outside the Church inspired by a passion for freedom and justice, he affirmed his belief that the Christian traditions, with those of humanism, science, and law and government, may still prove one of the great unifying forces of Europe, and one of the principal agencies for ensuring his fundamental rights and liberties to every European citizen.

The emphasis thus placed on a moral and spiritual basis does not absolve the great nations—Great Britain, the U.S.S.R., the United States, France—from the responsibility of leadership, as was frankly recognized by Lord Cranborne, and both points are implicit in the latest proposals which Lionel Curtis has outlined for giving effect to the Atlantic Charter. His recent pamphlet* includes the "Open Letter to Lords, Commons and Press" which was included in "Faith and Works". To some extent it covers the same ground as that pamphlet, but its argument is developed out of discussions which arose on the policy outlined in his earlier pamphlets in giving a series of lectures on the same lines to members of the Forces of the United Nations, mainly from those of Great Britain, the Dominions, India and the U.S.A.

The essential part of Mr. Curtis's argument is to be found in the first chapter, outlining a policy for post-war settlement, where the evolution of this policy from his earlier proposals and criticisms is clearly displayed. Agreeing with Walter Lippmann's view in "U.S. Foreign Policy" that no single democracy is now strong enough to prevent world wars, and that only an alliance between the American and the British Commonwealths can keep the peace for the next generation, Mr. Curtis voices his own conviction that the world will not begin to develop any real feeling of security from war until two or more democracies have shown how to merge their external powers in one common authority or union for defence. The danger of world war will be finally ended only when there has come into being an international authority for defence which includes the United States with other democracies. He is convinced that the root cause of world wars is the anarchy which exists between sovereign States, and the only way to stop them is to entrust defence to a common authority.

The federal solution which Mr. Curtis proposes is strictly limited to defence and to functions clearly inseparable therefrom, of which the control of foreign relations, which determine the issues of peace and war, is obviously one. The union authority must be empowered to make the common security from war a first charge on all the resources of all the nations

it safeguards. Mr. Curtis himself suggests that the cost should be borne in proportion to the taxable capacity of the several nations forming the union. In arguing for this transition from a national to an international control of defence, he urges that in this way the existing national cabinets and parliaments will have more time to devote to the equally urgent task of promoting social reform.

The key point which Mr. Curtis reiterates in this as in his earlier pamphlets, is that the British Government should have the candour and courage to tell the Dominion Governments that Great Britain and Northern Ireland can no longer provide the resource required to maintain forces by sea, land and air strong enough to protect the Commonwealth from further attacks, in accordance with the resolution passed by the Imperial Conference of 1926. From the inability of the British Government to offer effective guarantees to the French, Netherlands and Scandinavian democracies should come an invitation to the Governments of those democracies to join in the discussions with a view to the creation of some common authority equipped to provide a common defence for these countries as well as for the British democracies. Mr. Curtis believes that a union formed in this way would be more likely to secure the adherence of the United States than one which started with the United States and Britain. While paying tribute to the achievements of the League of Nations in technical and social fields such as health and the control of the traffic in drugs and in women and children, he has little faith in the functional approach and rests his case essentially on the stability of organic union once formed and on the enhanced capacity of democratic governments for overtaking their grown arrears in social reform when they have created a government charged with the task of common defence.

Beyond this, Mr. Curtis lays some emphasis on the union being limited at first to democracies and centring the capital of the Union from the outset on the North American continent. This scheme is thus narrower in scope and more fundamental than that outlined in the Dumbarton Oaks proposals, but it should be noted that Mr. Curtis is dealing with the long-term rather than the short-term problem, and he insists, with Lord Lothian, that there is no solution to the former problem without the acceptance of some limitations on national sovereignty. A understanding between Great Britain, the United States and the U.S.S.R. may avail to keep the peace during the next generation, but something more fundamental and organic is required beyond that. The Dumbarton Oaks proposals should be examined from the point of view of estimating whether they are likely to afford the necessary stimulus or opportunity for such developments. The Security Council and the Military Staffs Committee proposed at Dumbarton Oaks may be the first tentative steps in the direction indicated by Mr. Curtis, particularly if the regional sub-committees function effectively.

It is significant that much of the above is common ground in other proposals besides those of Mr. Curtis which have recently been advanced. Sir Walter

* *The Way to Peace*. By Lionel Curtis. Pp. 98 (London: Oxford University Press, 1944.) 1s. net.

ytton, for example, in his Sydney Ball Lecture, "The British Commonwealth and World Order"* from a survey of the distribution of population, territory, and industrial and commercial resources, concludes that we should advance to world order by the regional development of closer relations between nations. At this stage we should not put into a universal world covenant anything more than simple provisions for amity and for consultation. The regional arrangements should include the internal security of the groups themselves, that is, political provisions which will foster and guarantee personal liberty and economic collaboration to raise the standard of living. Meanwhile, however, a world association of a looser kind is necessary both to keep world peace and to insure that all regional arrangements are consistent with the interests and progress of the world as a whole. It will not break it up into sections, the conflicting ones of which may contain the seeds of future conflict. The looser association Sir Walter Layton suggests should be organized under the direction of a council containing representatives of the Great Powers, the large world groups, Latin America and the Moslem world. Above all, he insists—and here his proposals are more in line with those of Mr Curtis—on the urgent necessity of a radical advance towards unity in Europe in order to secure lasting peace. Here again he sees the solution in some form of federalism, which, as Mr Churchill's words, secure "the largest common measure of the integrated life of Europe that is possible without destroying the individual characteristics and traditions of its many ancient and historic peoples". The federal scheme which should cover all Europe outside the U.S.S.R. and Great Britain, and should be actively sponsored by those powers as well as by the United States, should place all the armed forces of Europe under the European authority or control, and a European Supreme Court should be established. The scope of the authority in economic matters should include supervision of the munitions industries and the regulation of cartels, and control, as far as possible, of all matters of inter-State commerce, especially rail and air transport, and Sir Walter refers in this connexion to the importance of continuing the existing organs of the United Nations for the distribution of food and raw materials. Finally, he insists that the lines of European union should be followed by the European peoples themselves before final peace is made with Germany.

Sir Walter, discussing last the role in world affairs of the British Commonwealth, points out that within the framework of such a world organization there would be advantage and no harm in close and continuous consultation between Britain and the dominions. Moreover, we should not imagine that democracy in any stereotyped form will spread to countries where it has not hitherto existed, but the ideals expressed in the Four Freedoms are goals to which people of every race and colour do aspire, and we can give the leadership for which the world is looking by demonstrating in our own domain that these aims can be attained, and using our great

influence in international affairs to assist other nations to achieve them. Ultimately, it is these ideas that will unify the world.

Mr Ely Culbertson closes his "Total Peace"* on a like note, but what professes to be the full exposition of his world federation plan already published in summary is a disappointing volume. The analysis of the present basis for peace, namely power politics, which occupies the first part of the book, scarcely provides a true historical perspective as claimed. Moreover, it sometimes seems more calculated to foster international misunderstanding and distrust than the policy of co-operation represented by the plan. Mr Culbertson seems to forget that some measure of good faith and common standards of value and conduct must be presupposed in any attempt to formulate an agreement whatever the sphere of action. The second part of the book gives a somewhat fuller exposition of the world federation plan than that in the "Summary" published last year.

There is, it is true, a superficial resemblance between some of Mr Culbertson's thought and that of Mr Walter Lippmann. Mr Culbertson frankly accepts American power politics as essential, but argues that they must be based on the renunciation of wars for the purposes of economic or political conquest. The ultimate object of American power politics must be the elimination of power politics in relations among States. Meanwhile, he lays down three basic principles for American power politics: first, the United States cannot permit any other great State to increase its power materially through conquest or domination; further, the United States must use its present power to ensure itself strategically against possible future aggression by one or more sovereign States; and, finally, it must establish, if possible, an adequate system of world collective security.

Mr Culbertson bases his belief in the possibility of collective defence on the segregation of the heavy weapons of war and the quota force principle, as already explained in his "Summary". From his third basic principle he derives the corollary that a system of collective defence acceptable to the United States must provide for all possible contingencies and must not deprive the United States either of its sovereign rights (except the right to wage war of aggression) or of its own military power to defend itself, as well as the further corollary that until a system of collective defence is fully established and thoroughly tested in operation, the United States must not abandon the first and second principles. All three principles or instruments must be used in United States foreign policy, and Mr. Culbertson gives vividness to his discussion by three charts in which is set forth the world pattern of 1945 and 1975 in comparison with that of 1900.

From this basis Mr Culbertson proceeds to destructive criticism of the policy advocated by Mr Walter Lippmann in "U.S. Foreign Policy" and E. H. Carr in "Conditions of Peace", and while he argues that the United States must not withdraw from Europe

* Barnett House Paper No 27 (London: Oxford University Press, 1944) 6d.

* Total Peace. What makes Wars and How to Organize Peace. By Ely Culbertson. Pp 274 (London: Faber and Faber, Ltd, 1944) 12s 6d net.

into isolation, he urges that she must oppose the establishment of any kind of British or Russian zone of influence in Europe. On the contrary, the United States must endeavour to restore their sovereign status as soon as possible to the liberated countries, and remain in Germany until the German people also are restored to a position of independence from the power politics of either Britain or the U.S.S.R.

These chapters of the book are profoundly disheartening and depressing. Mr. Culbertson, it is true, like Mr. Curtis, points to the essential weakness of the British Commonwealth in regard to defence, but though at times his criticism is suggestive, it is often shallow and unfair. True, he wishes to see the British Commonwealth preserved, and rightly says that the only lasting guarantee of its preservation lies in a system of collective security for the world. Unfortunately, he seems to forget 'saucy for the gander, saucy for the goose', and his argument for a system of collective security often appears to be inspired by a desire to perpetuate United States domination rather than by a conviction that her own true interests, like those of other nations, are best served by a collective system of security.

The two faults that seem to run through Mr. Culbertson's thinking are first his failure to recognize that the United States, no less than other nations, cannot have matters all her own way in any system of co-operation, international or not, there must be give and take. Inflated nationalism in the United States or in the liberated countries of Europe will assuredly be a stern obstacle to a collective or federal system. Secondly, Mr. Culbertson is too prone to impute bad faith to other countries. Confidence in the willingness of the United States to participate in a collective system will not be fostered by insisting on the necessity of strong safeguards against bad faith on the part of any and all other nations. It is, in fact, uneasiness about the extent to which the United States can be depended upon that, more than any other factor, is liable at the moment to paralyse the developments of the United Nations Relief and Rehabilitation Administration and the Dumbarton Oaks proposals. The outspoken article "Noble Negatives" in a recent issue of the *Economist* was a true service to the United Nations, no less than to the United States itself.

Mr. Culbertson's realism is in fact overdrawn. His anxiety to criticize destructively other schemes, such as the League of Nations and the Federal Union proposals of Clarence Streit, leads him to overlook the fact that all organizations or systems depend on human will-power and sympathy for their operation. Had there been sufficient determination, the League of Nations, with all its imperfections, might still have achieved its purpose. However mistaken President Wilson's tactics or maladroit his handling of the situation, and however understandable in the circumstances of 1919 the refusal of the United States to participate, that refusal wrecked the whole scheme, and there is nothing in Mr. Culbertson's book that encourages any confidence that that refusal will not be repeated on even less substantial grounds in the

future. Nor will confidence be restored by imputing bad faith to attempts to evolve an alternative system which might function without the co-operation or participation of the United States.

Unless this question of good faith and understanding is frankly faced, there can be no hope of any progress with the Dumbarton Oaks scheme or with any other. Criticism of mistakes there must rightly be, but that criticism should be tempered by the recollection that mistakes may be made in good faith and through information less complete than that available to the critic. Above all, criticism must be reasonable. If a world order is to be established after the War and a scheme of collective security operates, refusal to participate in a particular scheme must be accompanied by constructive proposals for an alternative scheme and a willingness to consent to mutual accommodation. The spirit in which the problem is approached is what matters, and without some moral basis there can be no hope for an enduring system of world order.

If the upheaval of war affords opportunities for shattering old institutions and loosening old associations, it also creates obstacles by the passions it arouses. In a long war tempers are tried, and men and women worn to the limit of human endurance may fail to view their problems with the patience, forbearance, understanding and wisdom all-important in such vital issues as those of world co-operation and reconstruction. That may well be a decisive reason for advancing slowly, taking the organizations set up for our war purposes, whether regional or functional, and adapting them to the new purposes of peace and reconstruction, and as confidence and sympathy are gained in working together, shaping them and completing them where required to form a wide and comprehensive system which gives full satisfaction to the needs and aspirations which the Dumbarton Oaks proposals are intended to meet.

THE PHILOSOPHY OF BERTRAND RUSSELL

The Philosophy of Bertrand Russell

Edited by Paul Arthur Schilpp (Library of Living Philosophers, Vol. 5) Pp. xvi+815. (Evanston and Chicago: Northwestern University, London: Cambridge University Press, 1944) 30s. net

A HIGH standard is reached by most of the twenty-one essays in this imposing volume. Limitations of space make it impracticable to notice them separately, but some account may be given of the picture of Russell and his philosophy which emerges from the work as a whole.

Bertrand Russell was born in 1872, the grandson (and ultimate heir) of the Whig statesman Lord John Russell, who was twice Prime Minister in the early half of Queen Victoria's reign. His mother was one of the Stanleys of Alderley, a family which has contributed many distinguished (and, it may be added, many picturesque and uncommon) figures to English public life. Both parents having died when he was a child, he was brought up by governesses and tutor

ld in his solitary studies pondered over questions which are not easily answered. At the age of eleven he was troubled over the foundations of geometry, by the time he was fifteen, he had become convinced that free-will was an illusion, and the next three years saw the destruction of his beliefs in immortality and in God.

During this period, Russell was influenced chiefly by the writings of John Stuart Mill. Now Mill, while generally following in the philosophical tradition of Hume, had tried to rescue mathematics and physics from the universal bankruptcy of knowledge which had been brought about by Hume's critical scepticism, and it was this aspect of his teaching that fired his imagination, and eventually determined the life-work of his young disciple. Mill's own solution was, in brief, that the character of necessity ascribed to the truths of mathematics, and even the peculiar certainty sometimes attributed to them, was an illusion, and that the axioms of geometry were inferences from experience. Russell found himself reluctant to accept the conclusion that mathematical propositions are empirical generalizations, though at the time he could not imagine what else they could be.

Russell's life of isolation ended at the age of eighteen, when he went up to Cambridge, which opened to him a new world of delight. He read for the Mathematical Tripos, and was seventh wrangler in 1893, after this he transferred to philosophy, then represented at Cambridge by Henry Sidgwick, James Ward, G. F. Stout and J. E. McTaggart, but the dominant influence on his thought came not from any of these but from A. N. Whitehead, who as a member of the mathematical staff was lecturing in non-Euclidean geometry, and Russell spent his fifth year in composing a dissertation on the foundations of geometry, which won for him a Trinity scholarship in 1895.

Russell's philosophical teachers had by this time drawn him away from the school of Mill. The metaphysical system presented by Stout and McTaggart as the absolute idealism of Hegel, which he accepted for a time, he became interested also in the neo-Platonic idealism of F. H. Bradley, whose "Appearance and Reality" was published in 1893, but it soon became clear that no satisfactory solution of the problem which dominated his thoughts—the discovery of a satisfactory philosophy of mathematics—was to be found in these quarters, and in 1898, chiefly under the influence of G. E. Moore—then a newly elected brother fellow of Trinity—he renounced German idealism completely, and, moving swiftly to the opposite pole of doctrine, came to believe that the material world of common sense exists, independently of whether anyone is aware of it, and also that there is a timeless world of Platonic ideas, that a search for reality is possible, characterized by all the seriousness and assurance of scholasticism, and at the same time in harmony with modern science, and that mathematics could be *quite* true.

The new outlook, however, did not immediately suggest any means by which this last confidence could be formally vindicated. Russell's great inspiration, the crisis of his intellectual life, came in 1900, at the International Congress of Philosophy in Paris, where he heard expositions of recent progress in symbolic logic, that is, the development of the principle that certain ideas in logic are the constitutive elements of all others, just as in chemistry all

molecules are constituted of certain chemical elements, these ideas can be represented by symbols, and the ideograms thus introduced are capable of replacing ordinary language completely for the purposes of any deductive theory. Russell was not unfamiliar with the subject, for it had been originated by Leibniz, of whose work he had made a close study, but he now learnt of the advances which had been made in the 1890's by Giuseppe Peano (1858–1932), of the University of Turin, whose ideography was far more powerful than anything previously devised.

Russell saw at once that with the help of Peano's logical calculus, it should be possible to extend the domain of precise reasoning backwards into regions which had hitherto been dim in the twilight of philosophy, perhaps even to discover the true foundations of mathematics. Peano himself had not achieved this, indeed he belonged to the 'formalist' school, who hold that any branch of mathematics consists of *primitive or undefined concepts* (for example, the concept of the straight line in geometry), *definitions* (that is, short names for complexes of ideas), *axioms* (that is, fundamental propositions which are assumed and which may be regarded as constituting an implicit definition of the primitive concepts), *existence-theorems* (proofs of the consistence and independence of the axioms, the existence of the entities introduced by the definitions, etc.), and *deductions*. In accordance with these principles, he based arithmetic on the 'undefined concepts' *number*, *successor* and *zero*, which was unsatisfactory, for it is precisely these three concepts whose nature is in question. It ought to be possible to define what number is, for the statement that we have ten fingers, two ears and one nose is intelligible to everyone, yet the definitions in the text-books of philosophy, such as "every number is a plurality held together as a unity", were obviously worthless.

Throughout the academic year 1900–1 Russell, who by now had an easy mastery of the Peano symbolism, worked at the problem and succeeded in proving that the whole numbers 1, 2, 3 . . . can be defined in terms of purely logical concepts (such as *class*, *not*, *or*) by means of the ideography, and that all pure mathematics can be built up on this foundation: thus 'mathematics is identical with formal logic'. This statement is obviously incompatible with the empiricist philosophy of mathematics which Russell had learnt from Mill, and also with the Kantian doctrine which he had learnt from his Cambridge teachers. According to Kant, mathematical proofs depend not on formal logic alone, but also on certain *a priori* 'forms of intuition', namely, space and time, so that, for example, the diagram is an essential part of geometrical reasoning. Russell's work demolished the empiricist and the Kantian views alike. Subsidiary to this great discovery, many improvements were introduced into the symbolic calculus itself, particularly a general theory of relations (the lack of which had been a defect in the older logic), the concept and extensive use of the propositional function (that is, an expression such as '*x* is a number' which contains a variable *x* and which becomes a proposition as soon as a definite value is assigned to the variable) and the treatment of implication ('*p* implies *q*' was defined as equivalent to 'either *p* is false or *q* is true', so that a false proposition implies every other proposition).

Russell's researches, in which he had throughout the intimate co-operation of Whitehead, were followed

eagerly by the younger mathematical fellows of Trinity College (E W Barnes, G H Hardy and myself), and in the Michaelmas term of 1901 he gave a course of lectures to an audience of half-a-dozen junior dons, dictating to us what might be described as the first draft of "Principia Mathematica". It would perhaps not be extravagant to regard these lectures as effectively the beginning of the modern renaissance in logic. While due credit must be given to Russell's precursors, especially to C S Peirce, Frege and Peano, it may be said broadly that the great expansion is to be dated from the "Principia". The successive volumes of the *Journal of Symbolic Logic* show that the best work is now being done in America.

The career of discovery had its dramatic moments. I remember Russell's look of mischievous glee when he announced a contradiction inherent in logic, which invalidated all human reasoning, this was, that if x is the class whose members are all the classes which do not contain themselves as one of their members, then from the assumption that x is a member of itself we can at once infer that x is not a member of itself, and *vice versa*. There are an infinite number of contradictions of this kind, and in order to deal with them, Russell introduced what is essentially a rule of syntax, imposing a ban on the construction of certain kinds of linguistic expressions, and thereby avoiding all formations which could lead to logical contradictions. The scheme depends on a classification of the objects of thought into a hierarchy of 'types', the rule being that the symbols which it is permissible to insert into any one context must be such as represent entities of the same type. The simple theory of types as originally formulated by Russell suffices to remove all those contradictions which are expressible in purely mathematical or logical terms: there are other contradictions, of a type called 'semantical' by his disciple Frank Ramsey, and these, as has been more recently shown, can be avoided by extending the theory of types into an analogous theory of 'levels of language'.

Russell has had to defend his position not only against formalists, Kantians and empiricists, but also against the school of mathematical philosophers known as 'intuitionists', who fix attention on the fundamental ideas of truth and falsehood, and ask Pilate's question, "What is truth?" Truth, they say, means 'verifiability', it would be a meaningless word unless there were ways of ascertaining whether particular propositions are true or not. Now in mathematics, when we are dealing with infinite systems, we meet with difficulties in this regard. Suppose, for example, we consider the proposition "In the number $\pi = 3.1415926536 \dots$, the sequence of digits 123456789 occurs at least once". Here no method exists which in principle would enable us to prove by a finite number of operations that this proposition is false. In such a case, the intuitionists deny that there is justification for asserting *a priori* that it is necessarily either true or false, a third category must be admitted, of indeterminate propositions, that is, the Law of the Excluded Middle, that 'every proposition is either true or false', is not of unlimited validity, in place of the two-valued traditional logic we obtain a three-valued logic. Russell's answer is, in brief, that while a three-valued logic may be admissible, there is no reason to suppose that the two-valued logic is inadmissible, and that the latter is to be preferred because of its greater potency for the development of mathematics and

physics. The abandonment of the Law of the Excluded Middle would, in fact, make it necessary regard large domains of traditional science as invalid.

Russell's discoveries in mathematical logic brought about some modifications of his philosophical outlook. In 1898 he had regarded the cardinal numbers belonging to the timeless world of Platonic ideas. In 1900-1, when he had defined 'number' in terms of the logical concept of 'class', it became no longer necessary to retain numbers as entities, and the ideal character was transferred to classes. But further reductions in the population of the Platonic heaven were to follow. In a celebrated paper "On Denoting" written in 1905, he discussed 'denoting phrases', as in particular 'descriptions', that is, phrases of the form 'the so-and-so', for example, "the author of 'Pendennis'". Some descriptions, such as "The Bishop of Oxford", apply to objects which exist while others, such as "The Bishop of Asquith", cannot. Reflexion on this difference had led to some muddled thinking by philosophers, the opinion being expressed that since "The Bishop of Asquith" could not sustain a predicate (thus, "The Bishop of Asquith has no valid Orders"), he must have 'being', though not 'existence'. In this paper, which was published in *Mind*, Russell's powerful logical analysis shattered such nonsense for ever. He showed how to reduce any proposition in which a denoting phrase occurs to a form in which no such phrase occurs, by recasting it into a statement about the values of a variable that satisfy some propositional function. The true analysis of the proposition is different from what was suggested by the grammar of its original formulation.

The logical analysis of description, then, does not lead to a definition of the descriptions themselves, but transforms the propositions in which they occur, in such a way that the descriptions are eliminated. The descriptions are not assumed to be themselves significant, though they are parts of significant sentences, just as the symbol of differentiation in the differential calculus acquires significance only when performed on an operand. The technique of the theory of descriptions was later (in 1910, in "Principia Mathematica") applied to all kinds of symbols which have a meaning in use (that is, in a context with other symbols) but not in isolation—'incomplete symbols', as Russell called them. He now showed that class-symbols could be regarded as incomplete symbols, thus statements about classes can be replaced by statements which mention only properties of the individuals who are (in the usual way of speaking) members of the classes, so that a class is not a genuine entity, but a 'logical construction', as Russell calls it.

The theory of incomplete symbols was afterward used extensively in order to reduce the traditional entities of mathematics and (after the completion of "Principia Mathematica") also of physics—points, instants, particles of matter, etc.—to logical constructions from empirical data. Scientific statements were thus related directly to sense-experience, and the traditional entities became superfluous. For a dozen years or more from 1914, Russell was much occupied in building up by this method a philosophical system of physics, taking as his fundamental principle William of Occam's maxim *Entia non multiplicanda sunt praeter necessitatem*, or as he formulated it in this connexion (Russell's 'Principle of Parsimony' as we may call it) "Wherever possible, substitute constructions out of known entities for inferences to unknown entities", so as to reduce the number of

ferred entities to a minimum. The raw material of the constructions consists of 'events', an event being something which occupies a small finite amount of space-time: thus electrons and protons are now constructed as series of groups of events. Russell's success in the endeavour to obtain by his constructions a 'minimum vocabulary' led to a change in his views regarding the problem of universals. In 1900 he had accepted the Platonic doctrine, but to-day he might perhaps describe him as a Parsimonious Realist, who believes that at least one universal is necessary, but is reluctant to admit any more.

It is to be remembered that Russell had come to philosophy through mathematics, and that a 'principle of parsimony' is naturally congenial to mathematicians, who enjoy showing that all the laws of the material universe are nothing but particular applications of Hamilton's Principle. In Russell's case, philosophical parsimoniousness gradually got a greater and greater hold, and eventually drove him to a new metaphysical position—caused him, in fact, to abandon the dualism of mind and matter which he had maintained for so long, and to revert to a monistic interpretation of the universe: not, however, to what he had renounced in 1898, but to a newer philosophy which had originated with William James and the American neo-realists, and which was now as 'neutral monism'.

The change came gradually. It began, in the first edition of "Our Knowledge of the External World" (1914), with a move towards a phenomenalist doctrine of matter: a physical 'thing' was there defined as a certain series of 'aspects', namely, those which would commonly be said to be of the thing or purposes of explanation, an 'aspect' may be thought of simply as 'what would be shown in a photograph of the universe taken from a certain point of view', a set of aspects constitutes one 'thing' when they form a group related to each other according to the laws of perspective, the aggregate of these aspects, perceived and unperceived, is the thing: his definition is obviously very much in the spirit of the definition of a cardinal number as a class of classes. The second stage was reached in "The Analysis of Matter" (1927), where Russell rejected the belief in consciousness as a fundamental characteristic of mind, which he now reduced to sensations and images.

Having arrived at the position that both matter and mind are bundles of ultimate constituents, the next step is to declare that these constituents, the aspects, are not specially either material or mental, but are the same 'neutral stuff' in both cases. Mind and matter are logical constructions: the difference between them consists in the different relations according to which the neutral entities are arranged, just as an ordinary dictionary consists of words arranged according to the alphabetic order of their initial letters, whereas a dictionary of rhymes for the use of versifiers may consist of the same words arranged according to the sound of their final syllables. Since the neutral entities are directly perceivable (or at least would be perceived if there were observers everywhere), the philosophy is essentially empirical, and indeed in some ways it recalls the teaching of Russell's first instructor, John Stuart Mill. The doctrine was somewhat modified in "The Analysis of Matter", published in 1927.

The advocates of neutral monism diverge considerably from each other in their presentations of it: and a close examination has revealed many diffi-

culties, the criticisms of Russell's version by Prof. A. O. Lovejoy in his book "Revolt Against Dualism" and by Prof. W. T. Stace in the present volume are impressive. On the whole, one feels that a metaphysic of this type is not likely to find wide acceptance except among those philosophers who have a strong *a priori* preference for monism over dualism. As Russell admits, such a preference cannot be based on any rational objection to dualism: it is, perhaps, most often the fruit of a more or less mystical belief in parsimony as a fundamental principle of the universe.

Russell's best work—and very wonderful work it is—has all been related in one way or another to logic: the reduction of mathematics to logic, the analysis of linguistic form (logical atomism), and the application of logical constructions in the philosophy of science. Mr. Santayana once remarked that he was inclined to say of Russell what Russell had said of Leibniz, that his philosophy was at its best in those subjects which are most remote from human life. With this judgment I agree: and so (space being limited) will confine myself to the bare mention that parts of the work under review deal with politics, sociology and religion.

EDMUND T. WHITTAKER.

GALEN AND THE EMPIRICAL SCHOOL

Galen on Medical Experience

First edition of the Arabic version with English translation and Notes by R. Walzer. (Published for the Trustees of the late Sir Henry Wellcome.) Pp. xi+164. (London, New York and Toronto: Oxford University Press, 1944.) 12s. 6d. net.

FABRICIUS, in his "Bibliotheca Graeca" (1717), lists one hundred and seventy treatises by Galen still extant, his list of treatises lost fills six and a half quarto pages. Kuehn's edition of Galen's works (1821-33), in spite of all its faults and for many years to come the best accessible collection, comprises twenty-two volumes. Ever since 1906, lost treatises by Galen have been recovered and edited—in Arabic versions. "On Medical Experience" is one of these 'lost' treatises. Its only manuscript was discovered in 1931 by H. Ritter at Istanbul. Here is the first edition of the Arabic text, which dates from the middle of the ninth century, with an introduction, English translation, and explanatory notes (chiefly sources and cross-references)—the work of R. Walzer, whose experience and previous work in the fields of Arabic and Greek science and philosophy account for the admirable execution of his task. The work is exceedingly well produced at a surprisingly low price.

There was first a translation from the Greek original into Syriac from the pen of the celebrated Syriac Hunan ibn Ishāc, the present Arabic text being a re-translation from the Syriac into Arabic by Hunan's well-known nephew, Hubaish. Hitherto only certain Galen fragments had been known to be of importance in the history of Greek epistemology, and by an ingenious guess had been attributed to the lost treatise "On Medical Experience". This guess has now been confirmed by the discovery and editing of the full treatise. It is certainly a genuine work by Galen, a product of his early days, and its chief importance lies in the

material which it adds to our scanty knowledge of the so-called Empirical School

Greek medicine reached its first climax in propounding a number of free observations, speculations and practical rules such as have come to us in the corpus of Hippocratic treatises. In the course of one or two centuries, free Hippocratic speculation and observation had developed into a rigid and dogmatic system. This, in due course, aroused strong antagonism—the Empirical School, the main tenets of which are reviewed in the present treatise. In this Galen wishes to give, for educational purposes, an example of a speech typical of a representative of the original Empirical School. He refrains from giving his own views, but lets the empiricist win against his dogmatic opponent. Whatever Galen's personal attitude towards empiricism, he may be seen as the embodiment of the second climax of Greek medicine, owing to his final combination of dogmatism and empiricism, which enabled him to raise medicine to the rank of an applied science based on experimental physiology and therapy. This places the importance of the present treatise in the right perspective. It sets out a discussion which may not be without significance in the philosophy of science and medicine in general, quite apart from its historical background and implications.

The dogmatist opens the discussion by declaring the 'Logos', that is, the knowledge of the 'invisible' laws behind the obvious and 'observable', to be essential. It limits the innumerable possibilities offering themselves to the person who confines himself to observation. As the alphabet enables us to comprehend the innumerable possible sounds, systematic knowledge cannot be dispensed with, if observation is to serve a purpose. It is the appreciation of the order of symptoms rather than mere observation of symptoms that matters. For example, convulsion following fever is a certain sign of death, fever following convulsion a sign of safety. The empiricist retorts with the arguments famous from other sources, for example, Celsus, that a sailor is able to sail at a given moment without having fathomed the 'Logos' of Nature, of elements and winds, etc. It is lack of experience, not of knowledge, by which the medical man is bound to fail, and it is the yearning for systematized knowledge which accounts for the divergencies in opinion as to the nature of such simple phenomena as digestion, which has been attributed in turn to cooking, decay, trituration and to heat, although mere observation shows that none of these processes can explain it. The dogmatist should say how the discovery of remedies, certainly a pure product of empirical search in Nature, can become what he calls 'technical knowledge' in which alone he places confidence. Obvious entities such as a 'pile of wheat', a 'people', an 'army' could be explained away if we start asking how many constituents are necessary for them—the logical trick of the 'Sorites' which is being refuted at length.

Most points which the empiricist makes in this discussion belong to the household stock of arguments of scepticism, medical and philosophical, such as formed a strong current of thought when, in the sixteenth and seventeenth centuries, the foundations of modern science and medicine were laid. Then Vesalius, Harvey, Van Helmont based their revolutionary views on a refutation of Galen and his system. It should be remembered, however, that criticism of systems such as advanced by the ancient

empiricists was largely destructive, and directed particular against anatomy and physiology as the 'scientific' basis of medicine. It was constructive on the discovery of new 'pharmaka'. On the other hand, the reader may be referred to the Linac Lecture of 1943, in which Prof Major Greenwood vindicated Galen, the experimentalist, keen observer and medical thinker, against the ill-fame of a dictator whose dogmatism is often said to have prevented progress in medicine for fifteen hundred years.

W. PAGEL

"STATISTICAL METHODS"

Statistical Methods for Research Workers

By Prof R. A. Fisher (Biological Monographs and Manuals, No. 5) Ninth edition, revised and enlarged. Pp. xv+350 (Edinburgh and London: Oliver and Boyd, Ltd., 1944) 16s net.

THE appearance of a further edition of "Statistical Methods for Research Workers" might easily pass almost unnoticed, for nine editions have appeared at regular intervals in the last nineteen years. In fact, the cessation of this flow would be more remarkable than its continuation. Yet we may be forgiven if we take the opportunity to glance back over the career of this now standard work, since familiarity may easily lead us to overlook its effect on biological and other research.

In 1925 the first edition was received with a coolness verging at times on hostility. While the originality of the work and the importance of the small sample theory which formed its basis were acknowledged, it was doubted whether Prof. Fisher's reader would be prepared to accept his methods in the absence of formal proofs. It was hinted that the soundness of these methods might not justify the author's confidence. It was feared that biologists in particular might well find the book unnecessarily difficult to read. In practice, of course, the soundness of Fisher's methods has been attested, partly by mathematical investigation, but perhaps more importantly in the biologist's eyes by the fact that they work. In fact, they work so well as now to be indispensable. In these circumstances, biologists, at least, have seldom felt called on to demand formal mathematical proofs prior to use, and while biologists have at times complained of finding the book difficult (which complaint may equally be taken as reflecting the deficiencies of current training in biological research), few have let this difficulty blind them to the profit which they gain from using Fisher's methods. The consequences are to be seen not merely in the improved analysis of biological data, but also in the improved design of biological experiments—an aspect of the subject which Fisher has always stressed. In its turn the book has benefited by being steadily expanded to include the new techniques which have arisen from the problems it has encouraged biologists to pose to its author. Two special outgrowths, which we may note, are "The Design of Experiments" and "Statistical Tables" the origins of which may be seen in the earlier work.

"Statistical Methods" is in fact, as already said, now a standard work, which has exercised, and must continue to exercise, its influence on research methods especially in biology. It is justly recognized as an essential part of all biological libraries and research laboratories.

K. MATHER

A QUANTUM THEORY OF THE ORIGIN OF THE SOLAR SYSTEM

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THE hypothesis of Kant and Laplace that the solar system originated by a gradual process from the contraction of a rotating nebula has become more and more improbable as the theory of such a process was investigated (cf Jeans¹). As a consequence, catastrophic theories of its origin have been put forward. In these theories another star, or even two stars, passed close to the sun, or collided with it. In this article, which lays no claim to do more than open the discussion of possibilities, I suggest a quite different catastrophic origin, namely, a quantum transaction or perhaps a series of such transactions. I shall try to show that on Milne's² cosmological theory, this is a plausible hypothesis, and further that certain other cosmological problems are made less difficult if it is accepted.

According to Milne's cosmology, the universe can be represented in two distinct ways. On the kinematical representation, time t has a finite past t_0 , of about 2×10^9 years or 6.3×10^{16} sec. Space is Euclidean, but every observer on a 'fundamental particle' has his own private space. The infinite assemblage of fundamental particles, identified with the nuclei of galaxies, is contained in a finite sphere of radius ct , expanding with the velocity of light. An observer on any particle judges himself to be at the centre of this sphere, with the others receding from him. The different private spaces are related by the Lorentz-Larmor transformation. On the dynamical representation the time $\tau = t_0 (\log t - \log t_0 + 1)$ has an infinite past, and the fundamental particles are at rest in a public hyperbolic space. The radii of planetary and atomic orbits are constant, as are the periods of planets and electrons, whereas in kinematic time and space the orbital radii and angular momentum increase with t .

One difficulty of the collision or encounter theory is the extreme rarity of such events. On some versions the expanding universe theory such encounters are more probable in the remote past, when the stars were densely packed. But in Milne's cosmology an encounter was never more probable in a given stretch of dynamical time than it is now. It could be argued that as the dynamical past is infinite, an encounter is certain. However, it is no part of Milne's hypothesis that the stars have always existed.

Milne has not yet succeeded in deducing quantum mechanics from his few and simple postulates. His mechanics are in fact mainly classical. However, he has considered the behaviour of photons. The quantum parameter h , defined as E/ν , where E is the energy radiated in a transition, and ν its frequency, is invariant on the kinematical time-scale, for the red-shift of the distant galaxies is explained by the Doppler effect due to their recession, and the energy radiated in an atomic transition is invariant on their scale.

The main difficulty to be overcome in any theory of the origin of the solar system is this. The total angular momentum of the system is about 3.3×10^{50} erg-seconds. This is conserved on the dynamical scale. Unless most of the mass of the sun is concentrated in a very dense core, all this angular momentum could be present in the sun, due to its

rotation, without its showing any more tendency to burst than does Jupiter at the present time. Hence some external source of energy must be postulated before it could emit the matter which condensed into the planets. The source of this energy has usually been supposed to be a star. I suggest that it may have been a photon.

The mass of the sun is about 2.0×10^{33} gm, that of the planets about 0.00134 of this value, the solar radius 7×10^{10} cm, and the gravitational constant 6.66×10^{-8} . The mechanical energy of the solar system is almost wholly given by the work required to lift the planets to their present orbits against solar gravitation. This again is almost equal to the work required to lift them to infinity, namely, $\gamma m M/R$, where γ is the gravitational constant, m and M the masses of the planets and sun, and R the solar radius. The kinetic energy and the energy of the fall from infinity to the present orbits involve corrections of the order of $\gamma m M/r$, where r is the radius of a planetary orbit. Since for Jupiter $r = 1100R$, these can be neglected.

$$\frac{\gamma m M}{R} = 5 \times 10^{45} \text{ ergs}$$

Now at first sight a photon of this energy (and therefore of mass 6×10^{10} tons) appears a ridiculous conception. It would have, on the kinematical scale, a frequency of 8×10^{21} sec⁻¹, and a wave-length of 4×10^{-62} cm. But now consider the conditions at time t , when t was very small. The radius of the universe was ct . It could not accommodate radiation of a wave-length greater than ct , and the past would be too short for such radiation to have accomplished even a single oscillation. At any time t there is a minimal possible size of photon, the frequency of which is of the order of t^{-1} . Probably it is a good deal less. This is borne out by the following consideration.

The mean lives of excited atoms liable to radiate light of visible frequency always appear to exceed 10^{-8} sec, though shorter lives are associated with higher frequencies. Thus out of a group of excited atoms existing from the beginning of kinematic time, only a minority would have radiated before $t = 10^{-8}$ sec, when the universe had a radius of 3 metres, or about 10^7 wave-lengths. At a time of the order of $t = 10^{-15}$ sec there could, on any hypothesis, have been extremely little visible radiation, as it could not have been produced by the ordinary radiation processes. This argument suggests that radiation of frequency less than t^{-1} is impossible, while radiation with a frequency less than about $10^6 t^{-1}$ is produced, if at all, with some difficulty.

We can conclude, then, that at $t = 10^{-72}$ sec the minimum photon corresponding to a completed oscillation would have had an energy of about 6.5×10^{45} ergs. So if there was any radiation at all at this time, it was sufficiently hard to lift the planets out of the sun, if the sun absorbed it. Its contribution of momentum would of course have been negligible. If some planetary matter was shot out of the solar system, and if some hydrogen was lost even from the major planets, the energy required must be multiplied by a small factor. If the radius of the sun was larger it must be divided by a small factor. But we can conclude that the earliest date for the formation of the solar system is about $t = 10^{-72}$, or $\tau = -4.1 \times 10^{11}$ years, that is to say, the earth cannot have revolved round the sun much more than 4×10^{11} times. An error of 5 in the exponent of t would alter τ by about 5 per cent.

At a time about $t = 10^{-75}$ sec the mmual photon, which on the dynamical scale had a period of 2×10^9 years at any date, would have had an energy and frequency about 1,000 times greater than a planet-generating photon. If absorbed by a star of solar dimensions it would have been sufficient to split it into a pair the distance of which was large compared with their radii. In such a case the parent star could not have contained enough angular momentum to allow its progeny to move in circular orbits. Otherwise it would previously have broken up by centrifugal action. Hence the orbits of distant binaries would be expected to be very eccentric, as in fact they generally are. On this hypothesis the more widely separated binary stars were formed about $1-2 \times 10^{10}$ years earlier than the solar system, on the dynamical scale, in agreement with the arguments based on gravitation, which ascribe to them an age of the order of 10^{11} years.

To return to the solar system, it may be asked whether it was formed by the absorption of a single photon, or of several in succession. The analogy with an atom, now less striking than at the time of Bohr's original theory, suggests the former hypothesis, but the latter must also be considered. The formation of the solar system would appear to have been in principle unobservable, since any radiation with which it could have been observed would either have passed through it unaltered or destroyed it. However, the correspondence principle can be applied to events of this character. The primitive sun, containing the angular momentum of the whole solar system, had a period of rotation of the order of a day on the dynamical scale, or somewhat more if it was larger than at present on this scale, while Jupiter has a period of revolution of about twelve years. When the correspondence principle is applied to an atom, we find that the frequency of the absorbed radiation lies between those of the atom in its initial and final states. If this was so for the formation of planets, the period of the photon required to produce the solar system (or Jupiter alone) is of the order of a year on the dynamical scale, so its frequency was about 2×10^9 times that of the minimum photon, and the epoch of origin was, on the t scale, about 2×10^9 times that calculated above as a minimum. Alternatively, we might argue as follows. The planet-making photon was a train of electro-magnetic waves. A train with a suitable period would set up electro-magnetic oscillations in the sun, which might lead to the ejection of one or more planets. Given the size and physical state of the sun, the period would be calculable. It would probably be rather shorter than that calculated above on the correspondence principle. In either case a photon would be most likely to be absorbed if it approached in the direction of the solar axis.

Since $\nu = 10^{72}$, and if T be the corresponding period on the dynamical scale, while t is the epoch of formation of the solar system, $\nu = t_0/tT$, hence if T is about a year, $t = 2 \times 10^{-63}$ sec roughly, whence $\tau = -3.7 \times 10^{11}$ years. If, on the other hand, the sun absorbed a number of photons (say 9 in all, in order to form the major planets with Pluto and the parent of the asteroids) the value of ν for Jupiter would be only slightly less, but that for Mercury would be about 10^{69} , while the values of T would not differ among themselves so much. In this case the origins of the various planets were strung out over a period of about 4×10^{10} years of dynamical time, while the larger satellites of the outer planets (but

probably not those of the earth and Mars) could have been generated by photons absorbed by these planets at a still later date.

We must now consider the probable state of matter at this time. There could, of course, have been no radiation from atoms, nuclei, or electrons, and it is fairly clear that all matter was fully ionized, since any atomic systems would be ionized by thermal collisions, and free electrons would be unable to enter quantized orbits by emitting radiation. Thus stars formed by gravitational condensation could only lose the energy liberated in this process by emitting matter. Their radii would be those at which protons and electrons were just lost. Thus the solar radius on the dynamical scale might well have been ten times its present value. If so, the energy of the postulated photon must be diminished by a factor of 10, which would only decrease the dynamical date — τ by 4.6×10^9 years. The planets would, however, lose a good deal of matter immediately on formation, so that their original mass was greater than at present. This would give a correction in the opposite direction, while tidal friction would give a smaller correction.

The planets remained gaseous for a very long stretch of dynamical time. About $t = 10^{-10}$ sec, loss of energy by radiation became appreciable, and by $t = 10^{-4}$ sec, or $\tau = -10^{11}$ years it was in full swing. By about $t = 10^{10}$ sec, or earlier, the planets had liquefied, and by $t = 10^{13}$ sec or $\tau = -1.5 \times 10^{11}$ years, the stars had contracted to normal stellar dimensions. These contractions were probably responsible for the origin of many close binary systems, of the moon, and perhaps of the asteroids. During more than 3×10^{11} dynamical years the planets were gaseous. I suggest that during this period most of them acquired days equal to their years, while the sun rotated in a period which was some sort of average of the planetary years. On contraction, angular momentum on the dynamical scale was conserved, and the days therefore shortened to their present lengths on the dynamical scale except in so far as they were lengthened by the ejection of satellites and by later tidal friction. This would involve contractions of the radii by factors varying between about 20 and 100. The exceptions may be said to prove the rule. Uranus has a retrograde relation. Its satellites revolve at a high inclination to the ecliptic, and that of Neptune has a retrograde motion. It would seem that tidal friction did not complete its work on the outer planets. The other cases of retrograde satellites are probably better explained by capture.

Energy is generally thought to be liberated in stars by the breakdown of unstable nuclei generated by thermal nuclear collisions. At present the rate of liberation is limited by the number of effective collisions, and is thus roughly constant in dynamical time. In the remote past nuclear breakdown was the limiting factor, so the sun's radiation per dynamical year gradually rose to its present level, and has been fairly steady through geological time. Since through most of the history of the stars and planets in dynamical time nuclei of all kinds were effectively stable, but thermal collisions occurred, and more over through a long dynamical period the minimum photons were capable of providing the energy for nuclear synthesis, it is suggested that the heavy elements, including the radioactive ones, were built up from hydrogen between the formation of the star and the effective beginning of their thermal radiation.

If the solar system was generated by nine or more photon absorptions, most of the stars in our neighbourhood must have absorbed several photons, and reduced planets. If it only absorbed one, the frequency of long-period binaries suggests that events of this type were not rare, so that our galaxy may include some hundreds of millions of planetary systems. If so, the field of biology is probably wider than has been suggested.

The galaxies have masses of the order of 10^{46} gm. This is the mass of a photon of period 10^{-32} sec., that is, of the minimum photon at $t = 10^{-32}$ sec. Even if the galaxies were originally particles of matter as closely packed as atomic nuclei, and therefore of rather less than the size of the sun, the energies needed to disrupt them into gas were considerably less than that of such a photon. Hence if the galaxies originated by the absorption of radiation, in which case some of Milne's 'fundamental particles' may still exist in a compact form, or even if their whole mass rose from radiation, they cannot date from before $= 10^{-32}$ sec., or $\tau = -5 \times 10^{11}$ years. Thus the long time-scale of about 10^{12} years deduced from a study of gravitational interactions of stars, which are naturally measured in dynamical time, appears as a consequence of Milne's theory.

The above arguments must be regarded as the attempt of a layman to deduce some of the consequences implicit in Milne's cosmology, consequences which he had partly envisaged when he wrote in 1936 that "all dynamical theories of the origin of the solar system may require drastic revision". I have doubtless missed other consequences as important as any which I may have elicited. Even if my hypothesis is found to be logically coherent, it may well prove, when fully developed, to be as untenable as Laplace's nebular theory. In particular, the secular stability of non-radiating ionized gaseous spheres and the relation of the uncertainty principle to the scale of time will require investigation. Above all, the details of the postulated process were in principle unobservable, and it will therefore be hard to test the proposed theory as rigorously as others have been tested in the past. This is a serious defect, since the value of a scientific theory increases with the number of ways in which it can be tested. But such of current physical theory has the same defect.

I have not suggested an origin for the postulated photon or photons. To do so would involve either a further step in a possibly infinite regress or the assumption that they were primordial constituents of the universe. They might, for example, have been generated by the acceleration of large charges during the origin of the galaxies. It may be asked what is their present state, if any of them have not been wholly or mainly converted into kinetic energy. The energy of a photon is invariant on the kinematic scale appropriate to the particle emitting it, but once a particle absorbing it is moving away from its source, its frequency and energy are lowered by the Doppler effect, and on the kinematical scale appropriate to such a particle, both vary as t^{-1} , where t is the epoch of absorption. Thus the postulated planet-making photons are now trains of electromagnetic waves of a period of the order of a year, and much too small to be observable in practice. The mass of matter at any time is thus the fraction of the mass at an earlier time which has not been degraded by the Doppler effect, and at a sufficiently early date most of the mass of the universe, or all of it, may have been radiation rather than matter.

In conclusion, I wish to thank Prof. Milne for his encouragement, and for elucidating several details of his cosmology in letters, and to emphasize that if the theory here sketched has any value at all, it will only prove its value by serving as a basis for exact calculations by persons better versed than myself in physics and astronomy.

¹ "Problems of Cosmogony and Stellar Dynamics" (Cambridge, 1919).
² "Astronomy and Cosmogony" (Cambridge, 1928).

³ "Relativity, Gravitation, and World Structure" (Oxford, 1935).
Proc. Roy. Soc. A, **154**, 22 (1936), **156**, 62 (1936), **158**, 324 (1937), **159**, 171, 526 (1937), **160**, 1, 24 (1937), **165**, 313, 333 (1937). *Phil. Mag.* **34**, 73 (1943).

By PROF E A MILNE, FRS
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PROF HALDANE's idea as developed in the foregoing article seems to me to be fundamentally important. As all may not be familiar with the details of kinematic cosmology, and as readers may have difficulty in keeping pace with the rapier-like speed of Prof Haldane's mind, I beg to be allowed to traverse some of the same ground in more pedestrian fashion.

To begin with, a word of explanation. I first announced my ideas on the two time-scales at the Blackpool meeting of the British Association, in a discussion on the origin of the solar system, but the consequences of the ideas were so bizarre that I felt it to be absolutely necessary to develop the formal and philosophical aspects of the theory in full detail before proceeding to the more speculative consequences. This programme I carried out in a series of papers published by the Royal Society during 1936-38, and, though hindered by war-work, in *Philosophy* (1941), in addresses before the London Mathematical Society (1939), the Royal Society of Edinburgh (1943), the Royal Astronomical Society (1944) and in a series of papers in the *Phil. Mag.* (1943). I am at present wrestling with the difficult problem of the conservation of linear momentum for gravitating bodies in the expanding universe, and I do not wish to be hustled. However, in *Proc. Roy. Soc. A*, **165**, 354 (1938), discussing the role of the correspondence principle on the two time-scales, I wrote "It is not a fanciful speculation to see in the interplay of radiation keeping t -time with matter obeying the classical laws of mechanics on the τ -scale a phenomenon giving rise to the possibility of change in the universe *in time*, and so an origin for the action of evolution in both the inorganic and organic universes". A possible mode of that interplay has now been pointed out by Haldane.

I have long been aware that all theories of the origin of the solar system require drastic re-consideration in the light of the fact that at times of the order of $t = 0$, when the solar system was born, dynamical and optical conditions were very different. Haldane works with equal facility in either time-scale, but it must be remembered that the τ -scale is a concession to our Newtonian predilections, that it has in its description a constant t_0 (the present age of the system on the t -scale) which has nothing to do with *phenomena*, it has to do only with the language by which we describe the phenomena. Phenomena themselves are best studied through the t -scale, and in this scale the precise value of t at the epoch studied is all-important.

In Haldane's calculation of the order of magnitude of the energy required to be communicated to the

sun to form the solar system of planets, he uses the formula $\gamma m M/R$, with the present values of γ and R . It might be objected that on my theory $\gamma \propto t$, and that therefore the required energy was then much smaller. The answer is that $R \propto t$ also, that energy is a 'time-invariant', and that Haldane's calculation is accordingly correct. On his data, the value of $\gamma m M/R$ is 5×10^{46} ergs, as he says.

Previous speculators on the early history of the universe had always argued that since the universe is expanding, collisions must have been then more frequent, forgetting that lengths of material objects (that is, radii) would have then been much smaller. By translating to the τ -scale (stationary universe) we see that collisions would be just as frequent, or as infrequent, as now. The new contribution which Haldane makes is that the optical situation would be entirely different. At epoch t , when the radius of the expanding universe was ct , there cannot well have been photons of wave-length exceeding ct . The inequality $l < ct$ implies for the frequency n the relation $n = c/l > 1/t$ (Here l and n are measured on the t -scale.) Working again on the t -scale, the inequality $\Delta E = h_0 n > h_0/t$ gives the minimum permissible photon energy. Taking $h_0 = 6.55 \times 10^{-27}$, at epoch $t = 10^{-12}$ sec, we get $\Delta E > 6.5 \times 10^{16}$ ergs, so that such photons as were then possible would have sufficient energy to disrupt the sun and form a solar system.

There is no difficulty as to where the photons could come from. For according to kinematic relativity the mass (actual) and energy of the universe are infinite, and light must be present. Hence it must be, at small t , of enormous frequency and energy. The state of material atoms would be one of complete ionization, and the history of any photon would be one of successive degradations of frequency by interaction with matter, until at the present epoch light is *mostly* as we know it. This degradation of the individual photons due to interacting with matter must be distinguished from their constancy of frequency in time (t -scale) as they are propagated through empty space.

The epoch at which a photon ΔE was not less than 6.5×10^{16} ergs was, on the t -scale, 10^{-12} sec. The τ -measure of this epoch was $\tau = t_0 \log(t/t_0) + t_0$. The 'time ago' at which it occurred is $\tau_0 - t$, where τ_0 , the present epoch on the τ -scale, is equal to t_0 . This gives

$$\begin{aligned}\tau_0 - \tau &= t_0 - \tau = t_0 \log_e(t_0/t) \\ &= 6.3 \times 10^{16} \times 2.3 \times \log_{10}(6.3 \times 10^{16}/10^{-12}) \text{ sec} \\ &= 6.3 \times 10^{16} \times 2.3 \times 88.8 \text{ sec} = 4.1 \times 10^{11} \text{ yr.}\end{aligned}$$

in agreement with Haldane. This is of the order of the 'long' time-scale estimated by gravitational methods, that is, on the τ -scale.

Haldane's fundamental idea (pressing it to its limit) may be stated in the form that, just as the epoch $t = 0$ is a singularity in the mechanical t -history of the universe—an epoch at which the density was infinite—so the epoch $t = 0$ is a singularity in the optical history of the universe, namely, an epoch at which the frequency of radiation was infinite, because the wave-length had to be zero. Actually we can only make significant statements about the radiation for *small* epochs t , when the frequency would on the whole be very large. A spectrum would soon come into existence, by the absorption and backward emission (or backward scattering) of radiation by the naturally receding particles, with resulting degradation of frequencies by the cumulative Doppler effects.

But some of the original high-frequency radiation would traverse space unscathed, and, in spite of the inevitable Doppler effect at the terrestrial receiving end, a small fraction of this would retain a still very high frequency, and might be the origin of the undulatory component of the present cosmic rays.

I think it would be wise, in this preliminary discussion of Haldane's idea, not to go into details as to how a primordial photon of huge energy could disrupt a star. It is sufficient to dwell on the remarkable result that Haldane has deduced from kinematic relativity, namely, that at very early epochs in the history of the universe, such photons as there were must have possessed enormous energies.

WIREWORMS AND FOOD PRODUCTION

By HERBERT W. MILES

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WIREWORMS are undoubtedly the most notorious of all insects of agricultural importance, probably because their depredations are more extensive at times of agricultural expansion and prosperity. The traditional agriculture of Britain has been mainly the type known as 'mixed farming', and the measure of prosperity has been the extent of land under the plough. Wireworms are grassland insects, and so long as grassland is undisturbed they are of no economic importance. Periods of agricultural depression are periods of increasing areas of grassland, both cultivated and derelict, and consequently, periods in which the numbers of grassland insects increase. Events that lead to high prices for cereals—the Napoleonic wars and the Corn Laws in the first half of the nineteenth century, and the German wars in the twentieth century—are associated with the ploughing up of grassland, and the enhanced value of the crops stimulates the interest of the farmer in the causes of crop failure. It is a simple proceeding to pull up dying plants, and only too frequently the expected wireworms are found at their roots.

In reports of the Board of Agriculture during the War of 1914–18 it was noted that in specified districts wireworms were responsible for the "complete destruction of cereal crops". Although it is doubtful whether wireworms caused all the loss imputed to them, the prospect of another European war and the consequent need for a great increase in cereal growing in Britain made imperative some reconsideration of the wireworm problem. The difficulties confronting the agricultural advisory entomologists were considerable. During the post-war years there had been little investigational work on wireworms, and their occurrence as a field pest had only been occasional in a period when cereal production was declining and little established grassland was being broken for arable culture. Farmers required advice and assistance long before the five-year period necessary for the observation of the wireworm life-cycle could be completed and while only the scantiest of information was available on the distribution of wireworms in the soil and the density of wireworm populations. The scale of the national ploughing policy and the speed with which it had to be carried out precluded the development of direct control measures aiming at wireworm destruction and compelled resort to modifi-

nation of agricultural practice and choice of crop to avoid loss through wireworm attack

How the wireworm problem has been dealt with is described in a recent publication of the Ministry of Agriculture and Fisheries¹. The collaborators in the work were sixteen official entomologists with their staffs, and a statistician. Their primary task was to find a technique suitable for assessing wireworm populations on an extensive scale with reasonable speed and accuracy. The study of soil fauna has been hampered by technical difficulties of extracting animals from soil. Wireworms vary in length from 1 mm to 20 mm, and unless soil structure is completely broken the smaller wireworms may be trapped in the soil aggregates. The usual methods of extracting wireworms from soil are hand-sorting and flotation. Hand-sorting has obvious limitations, particularly when the heavier types of soil are involved. Extraction by flotation presents difficulties regarding the transportation and disposal of soil, the need for special laboratory facilities and equipment, and the likelihood of cannibalism among wireworms in stored soil.

Circumstances compelled the adoption of hand-sorting as the standard method of wireworm extraction for war-time advisory work. It was recognized that only the larger wireworms were found by this method, but since they were mainly responsible for crop loss it was considered that hand-sorting revealed the effective wireworm population with reasonable accuracy. At some of the advisory centres where necessary facilities existed a flotation method of wireworm extraction was adopted, but the greater efficiency of extraction was offset by the sacrifice of other detail. The recognition of the limitations of the extraction methods used by the advisers led to the evolution by Salt and Hollick² of a mechanical means of extracting wireworms from the soil. This apparatus is designed for research work and should stimulate the study of soil fauna, since it affords for the first time a reliable means of separating from the soil minute insects and other creatures, insect and other eggs, and eelworm cysts.

Lack of information on both horizontal and vertical distribution of wireworms in the soil and on their seasonal movements complicated the problem of estimating wireworm populations, but statistical examination of series of numbers of wireworms from soil blocks of various sizes suggested that reasonable accuracy might be obtained by the examination of twenty more or less evenly distributed core-borer samples 4 in. in diameter and 6 in. deep. Sampling of this intensity involved the careful scrutiny of approximately a hundredweight of soil in each field (the average size of 34,000 fields was rather less than ten acres), and demanded a high standard of integrity in the part of field workers who often carried out the examination in the open in poor weather. The probable limits of error of population estimates calculated on the basis of such sampling is discussed in the bulletin, and the possibility of both under- and over-estimating had to be allowed for in formulating advice.

In making a survey of wireworm populations in grassland scheduled for ploughing in various parts of England and Wales, in conjunction with observations on crop performance in surveyed fields, the advisory entomologists hoped to obtain information on the distribution of wireworm population, the crop loss associated with various population densities, and the influence of such factors as geographical position,

soil type, fertility and agricultural management on wireworm populations and crop loss. By the autumn of 1943 wireworm population estimates had been made on more than 34,000 fields, and the bulletin gives wireworm distribution maps showing that populations tend to be higher in the east and south-east and lower towards the west and north. The grouping of fields into those having 'high', 'medium' and 'low' wireworm populations was arbitrary, but it must have given confidence to farmers and war agricultural committees to know that in 50 per cent of the fields scheduled for ploughing wireworm populations were considered low and not likely to cause serious loss of crop.

Observations made in the course of the survey indicated that crop failure was the result of the complex interaction of a number of adverse factors, and only in about one field in six were wireworms sufficiently numerous to be a serious menace to crop production. Such factors as soil conditions and fertility, the standard of cultivation and the use of good-quality seed protected from seed-borne diseases, were so important that where they were satisfactory good cereal crops could be produced in fields where the effective wireworm population was well in excess of a million per acre.

The survey has not revealed any reliable correlation between the level of wireworm population and soil texture, soil moisture, fertility and agricultural management, but it has shaken some widely accepted beliefs concerning the incidence of wireworms. Poor, undergrazed, badly managed grassland where coarse tufted grasses prevailed was thought to encourage wireworm development, but when counts were made it was found that wireworms were generally most numerous in good grassland, and some of the highest recorded populations were found in Romney Marsh and Leicestershire in some of the best permanent pastures in Britain. Light loams and sandy soils had been associated with severe wireworm injury, but the survey showed that in most counties higher wireworm populations prevailed in the heavier types of soil.

The success that has attended the remarkable expansion of arable cultivation fostered by the Ministry of Agriculture has been due largely to the close co-operation of farmers, technical agricultural officers and specialist advisers. Through the study of crop performance on newly broken grassland, the advisers in entomology have been able to suggest crops that might be successful on land heavily infested with wireworms, and to recommend modifications of farm practice, such as the adoption of heavier seeding-rates, that would assist the establishment of satisfactory stands of plants in spite of thinning by wireworms. The knowledge that scientific workers and agricultural technicians were deeply concerned with the problem of crop production helped to check a fatalistic attitude among farmers forced to adopt systems of farming for which they had neither the implements nor the experience, and the obvious success of arable crops in what were often considered unfavourable circumstances encouraged farmers to make the best of tools placed at their disposal, fertilizers that were available and their own skill and experience.

To those concerned with pest control on agricultural crops the survey has induced a more critical attitude to crop failure and placed increased emphasis on the importance of high standards of cultivation and fertility. Market garden and fruit crops have

a high intrinsic value, and are grown on a comparatively small scale, therefore expenditure on the destruction of insects and fungi attacking them is economically justified, but for farm crops, only indirect methods of dealing with pests and diseases are practical. Like the medical officers of health, the plant pathologists concerned with agricultural crops must study conditions in which disease occurs and aim at developing preventive rather than the much more costly curative measures. Wireworms are present in practically all agricultural land, but the farmer who can maintain satisfactory standards of fertility and husbandry will suffer little loss from moderate wireworm populations.

The problem of how to balance the necessary periods of rest under grass when wireworm populations increase, with periods under arable culture when they are dispersed, has still to be tackled. This is long-range work that will require comprehensive biological, ecological and insect physiological studies. The change from war-time to peace-time agriculture will provide the field conditions required for the work. The solution of this problem would assist in the establishment of a flexible agriculture and remove from the mind of the farmer the fear that the benefits accruing from resting land under grass would be dissipated by the depredations of wireworms.

¹ Bulletin 128 "Wireworms and Food Production" (H.M. Stationery Office 1s.)

² *Ann. App. Biol.* 31, 52 (1944)

OBITUARY

Sir Buckston Browne

GEORGE BUCKSTON BROWNE came of a line of medical men, he being a representative of the fifth generation. He was born on April 13, 1850, of wealthy parents, his father being Dr. Henry Browne, physician to the Manchester Royal Infirmary and lecturer on medicine, and his mother, Ann Hadfield. He was an only son, two sisters rose to eminence in the civic life of Manchester. His mother died while he was still in his boyhood, the father, who was deeply religious, and son drifted apart, it is customary to blame the Victorian father for the clash which separated son from father, but those who knew Sir Buckston in his later years will realize that the clash may have been due as much to the son's opinionative wilfulness as to the father's Calvinism.

However this may be, Buckston Browne, in 1866, when he was sixteen years of age, resolved to leave the paternal home, he asked for, and was given, an allowance of £3 per week with which to feed, clothe and educate himself. He had been at Amersham Hall School for four years and had passed the matriculation examination of the University of London. He went to London, resolved to carry out his boyish ambition of becoming a medical man. With this object in view he entered as a medical student of University College, he laboured day and night to make himself proficient in his profession, in 1873 he won by open contest the proud position of being 'house surgeon' to Sir John Erichsen. Then in 1874, at the age of twenty-four, he entered the world of 'incomes', he had become a member of the Royal College of Surgeons, he augmented his paternal allowance by earning £8 a month by demonstrating in the dissecting room and coaching in anatomy at the rate of 2s 6d an hour.

It was at this juncture of his affairs that Buckston Browne engaged himself as private assistant to Sir Henry Thompson at the rate of £200 a year. Sir Henry was surgeon to University College Hospital and recognized as the leading authority on all diseases of the genito-urinary system. At the time he entered into this contract with Sir Henry Thompson, he made a love marriage, choosing as his wife Helen Elizabeth Vaine, of Sparsholt, Hants. He was often heard to declare that his success in his profession was due, not to his patron, but to his wife. It was a happy companionship which endured for fifty-two years, coming to an end in 1926. They had two children, a son and a daughter, the daughter became the wife of Mr. Hugh Lett, surgeon to the London Hospital—later Sir Hugh Lett, Bart., president of the Royal College of Surgeons, the son, George Buckston Browne, won the D.S.O. in the first World War, dying in 1919 from war service, leaving a son, the sixth George Buckston Browne, who died in 1924, the last of the male line.

The first period of Buckston Browne's professional life in the West End of London was spent in the service of Sir Henry Thompson and in laying the basis of his own practice. He had no hospital appointment to commend him, he had failed to pass the fellowship examination of his college, but he possessed a rare delicacy of manipulative skill and a profound knowledge of all ailments of the bladder, particularly those due to enlargement of the prostate. On Sir Henry Thompson's retirement, all such cases found their way to Buckston Browne's consulting rooms, elderly gentlemen who nowadays suffer from enlargement of the prostate submit themselves to the one major operation, but at the period with which we are dealing, they were educated to lead what was known as the 'catheter life' under the immediate care of their surgeon. Buckston Browne devoted himself to his practice so wholeheartedly that in less than forty years he had attained a financial success which has rarely been equalled in the annals of medical London.

Thus it came about that in the year 1927, Buckston Browne found himself a wealthy but lonely man, he had lost the companionship of his wife, his son and grandson were dead, his larger ambition, to participate in public life, was unsatisfied. In this year the British Association, meeting in Leeds, appealed for a fund which would enable it to purchase Darwin's home at Downe, Kent, and preserve it as a national memorial. Buckston Browne at once offered to provide the money needed. In his youth he had served under Huxley at the School of Mines and had been a lifelong admirer of Darwin. The goodwill of the Darwin family made the purchase of Down House possible. He spent upwards of £10,000 on the restoration of the house and grounds, adding a gift of £20,000 for its upkeep. The British Association was thus able to open house and grounds to the public on June 7, 1929.

Buckston Browne then turned his beneficent activities towards his old college, the Royal College of Surgeons of England. On February 4, 1931, he addressed a letter to the Council of the College in which this sentence occurs: "I ask you to grant me the great privilege of building and endowing a Institution of Surgical Biological Research in which surgeons, particularly young surgeons, will have the opportunity for carrying out their investigations."

Ultimately, he conveyed stock to the value of £105,000 to carry out his scheme. He remembered

an essential John Hunter found his farm at Earl's Court to be for the completion of his experimental work, and hoped that the institution or farm he had in mind would serve young surgeons as an 'Earl's Court'. He bought land adjacent to the Darwin estate as a site for his institution, now known as the Buckston Browne Farm for Surgical Research. It was opened in 1933, but with the coming of war all research workers were called to the field, the laboratories being taken over by the Emergency Health Service. With the return of peace we may hope to see it restored to its old activities.

Among his intimate friends Buckston Browne numbered Sir Thomas Barlow, both were from Lancashire, they met as students at University College, they occupied houses in Wimpole Street which faced each other. On January 11, Sir Buckston was carried to his old hospital, suffering from a

fracture of the neck of his femur, he died on January 19, well advanced into his ninety-fifth year. As he lay in the hospital, where seventy-three years before he had been house surgeon, his senior friend shook off the burden of life, having reached his hundredth year.

In 1931 the University of Aberdeen conferred its honorary LL.D. on Sir Buckston in recognition of his services to surgery. In 1932 he received the honour of knighthood, when he discarded "George" from his name, wishing to be known as Sir Buckston Browne. A. KEITH.

In *Nature* of October 28, 1944, an obituary notice was printed of Prof. Gustav Gilson. We have since been informed that Prof. Gilson died on January 1, 1944.

NEWS and VIEWS

Anglo-French Society of Sciences

At the beginning of the War, a number of scientific men in England and France became conscious of the lack of close knowledge and contact between the science and scientific workers of the two countries. As a result, they founded in April 1940 an Anglo-French Society of Sciences to assist the removal of this lack of mutual knowledge. The Society was organized in two groups, under the presidencies of Prof. P. A. M. Dirac and Prof. F. Joliot. The occupation of France interrupted normal proceedings, but during the occupation some members became very prominent in the French resistance movement. The liberation of France has enabled the Society to hold its first conference, which was on the topic of "The Old State", and was held in London on January 20 at the Society for Visiting Scientists. Prof. F. Joliot and Mme. Irene Curie-Joliot travelled from France to take part in the proceedings, and were accompanied by Prof. Wyart, Dr. J. Laval and Dr. Mathieu. Papers were read at the conference by Prof. N. F. Mott, Sir Geoffrey Taylor, Dr. Laval, Dr. Mathieu, Dr. Guerner, Prof. Wyart and others.

Members of the Society were entertained to tea at the House of Commons by Sir Robert Bird, chairman of the Anglo-French Parliamentary Committee. In reply to speeches by Sir Robert Bird and Mr.

W. Salt, chairman of the Parliamentary and Scientific Committee, Prof. Joliot spoke on the contribution of science to international understanding, and its place in the conduct of affairs. Science tends to clarity of mind and rational method, and it should be introduced into all aspects of a nation's life, including many where it may not hitherto have been customary. Prof. J. Hadamard referred to David Hume's famous remark that British soldiers fight and die in order that British judges may judge according to their conscience, the devotion of the English and French to that ideal is a binding link between them.

Medical Education in Great Britain

In a reply on January 18 to a question in the House of Commons regarding the Goodenough Report on Medical Schools, Mr. Willink stated that the Government recognizes the fundamental importance of medical education and research to the future of the health services of the country, and accepts the

principle of increased grants for the purposes of medical education and research to be distributed by the University Grants Committee through the universities to medical schools, postgraduate schools and institutes and hospitals used for teaching and research. The Government also accepts the suggestion that for a limited period these additional grants should be separated from the block grants received by universities for their work as a whole. As regards the views expressed in the report on the importance of affording to women equal opportunities to those enjoyed by men for medical training and for obtaining postgraduate experience, the Government has decided that future payments of grants to medical schools should be conditional on the adoption by the school of the principle of admitting a reasonable proportion of students of both sexes. It is proposed also that the University Grants Committee, in consultation with the university authorities concerned, should be responsible for determining from time to time whether the action taken by each of these schools complies reasonably with the principle. Equal importance is also attached to the revision of the medical curriculum, and acceptance of the principle of increased grants for medical education and research depends on the early completion of such a revision.

Tuberculosis Mortality in the United States

According to J. Yerushalmy, principal statistician, H. E. Hilleboe, senior surgeon, and C. E. Palmer, surgeon, United States Public Health Service (*Public Health Rep.*, 58, 1457, 1943), the average annual number of deaths from all forms of tuberculosis in the United States in the period 1939-41 was 10,429 (45.9 per 100,000 of the population). Mortality from tuberculosis was 41 per cent higher among males than among females, and three and a half times as high among non-whites as among whites. Death-rates for all forms of tuberculosis were higher in the older age-groups than in the younger. Among children and young adults the rates were higher for females than for males; but in the older groups the rates were much higher for males. Nearly one half of all tuberculosis deaths occurred at the ages 20-44. The death-rate from tuberculosis for males was higher among residents of large cities than among residents in intermediate sized cities, and that of the latter was much

higher than the rate for residents in rural areas. Tuberculosis mortality has decreased continuously since the beginning of the century, the rate in 1941 being less than one fourth that in 1900, and has fallen at a greater rate than mortality from all causes.

Commercial Fish Catch of California for 1941 and 1942

Fish Bulletin No. 59 of the California Department of Natural Resources, Division of Fish and Game, Bureau of Marine Fisheries (1944), by the staff of the Bureau, contains detailed records of fish delivered by commercial fishing boats to Californian ports. In addition, shipments of fresh fish by truck, rail or cargo vessel to Californian factories from outside the State are included. There is much information in this report. The value of all landings is tabulated, the 1942 values reflecting the higher war prices and price-ceilings fixed by the Federal Government. Although the value is much increased, the weight in pounds is less. The decrease in volume of the 1942 catch was due to reduced numbers of the better class of fishing boats and of experienced fishermen, as well as to the restrictions placed upon the free movement of fishing vessels necessitated by Army and Navy coastal defence plans. The sardine *Sardinops caerulea*, heads the list both in weight and value, the Pacific mackerel, *Pneumatophorus diogetus*, and the yellow tuna, *Neothunnus macropterus*, coming next. Various shell-fish occur in much smaller numbers. It is interesting to note that crabs (*Cancer magister*) average 2 lb. each and abalones (*Haliotis* spp.) 50 lb. per dozen. A useful list of common and specific names of fishes, crustaceans and molluscs is given.

Soil Conservation in Kenya

IN his first broadcast, on December 27, since he assumed office as governor of Kenya, Sir Philip Mitchell dealt with one of the Colony's most pressing problems—soil erosion. He illustrated his talk by reference to the Ukamba Reserve, where the far-advanced state of soil deterioration is causing grave anxiety. Here, Sir Philip said, is a salvage job which must be put in hand immediately. Much useful agricultural engineering work has already been done, but work needs to be greatly accelerated, otherwise "in a few years time there will be nothing left of the Ukamba Reserve". Concurrently, a social reorganization leading to a changed attitude of the African to his land must be carried through. Sir Philip sees most hope for soil conservation in the establishment of a landlord-tenant relationship, the landlord being the tribe as a whole, and the tenant the head of the family. Such a system would ensure the greatest possible security of tenure for the good cultivator and none for the incorrigible land miner. But he sees no short cut to the ultimate goal of restoring the land to a state of stable fertility.

Merseyside Naturalists' Association

THE third war-time portfolio of the Merseyside Naturalists' Association, an attractively bound volume of two hundred and fifty pages comprising sixty-five pages of photographs and coloured plates and forty-three original articles, has been edited by Miss J. Linaker. It includes detailed accounts of regional bird-life at Mold, North Wales, by J. Lord and C. Swaine; Wigan and Leigh flashes, by G. Brown and T. Edmondson; Hoghton, by G. C. Miller,

a Mersey shore pool, by F. J. Hartley; St. Andrew, the Midlands and war areas of Italy and North Africa, the president, Philip Ashcroft, describes his researches into the history of Martin Mere, the lake of 3,000 acres that once covered west Lancashire. Eric Hardy has a detailed account of the extinct and earliest known fauna of the north-west of England, and Mrs. E. G. Hardy describes how nestling hedge-sparrows were killed by a colony of brown ants. There is much that is of more than local interest. The raven is increasing its nesting range on the North Wales border, the curl-buntail has definitely been established as a nesting bird in west Lancashire, while the colliery subsidence water of south Lancashire are now known to be an important passage haunt of several rarer ducks, waders and wild swans.

Bibliography of Seismology

THE *Bibliography of Seismology*, 13, Nos. 14 and 15, Items 5564 to 5787, July 1943–June 1944, published by the Dominion Observatory, Ottawa, Canada, have just been received. In them are listed in full, occasionally with comments, papers and books from all parts of the world except Germany and Japan, dealing with pure and applied seismology. An interesting article listed in No. 14 is item 5571 by Centano-Grau, M., "Estudios sismológicos en Litografía del Comercio", pp. 555, 2 maps, 5 tal. Caracas, 1940, which gives a comprehensive review of many phases of seismology, and puts forward a theory of electrical causes for earthquakes of volcanic origin. The book contains a complete catalogue of earthquakes of Venezuela, and a study of the destructive shocks, including predictions of probable recurrences in different regions. In Nos. 14 and 15 numerous papers are listed dealing with rock bursts, chiefly in Canada and South Africa. One important paper is by Ernest A. Hodgson, "What is a Rock Burst?" published by the *Northern New* at Kirkland Lake, September 9, 1943, after a radio talk by the author. Other papers are by J. Spalding and include such topics as "Description of a Rock Burst", "Theory and Practice of Ground Control", and "Theory of Rock-Pressure" (*Kolar Gold Field Mining and Metallurgical Society Bulletins*, 8, No. 4, 153, Johannesburg, 1935–37). An interesting theoretical topic is listed as item 5709 in No. 15, Finch, R. H., "The seismic prelude to the 1914 Eruption of Mauna Loa" (*Bulletin of the Seismological Society of America*, 33, No. 4, 237, 1943). The paper presents evidence that the eruptions of Mauna Loa are preceded by pronounced seismic activity, but that this activity falls off for a month or more prior to the actual eruption. This paper may be considered a sequel to Harry O. Wood's paper in the same journal in 1915 on the 1914 activity. Items from *Nature* are listed in both parts of the bibliography.

Announcements

PROF. J. M. MACKINTOSH, professor of public health in the University of London and dean of the London School of Hygiene and Tropical Medicine, has been appointed a member of the Fuel and Power Advisory Council.

DR. J. G. DAVIS, of the National Institute for Research in Dairying at Shinfield, near Reading, has been appointed scientific adviser to the Express Dairy Co. Ltd., London.

LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications.

Nitrogenous Substances Synthesized by Moulds

DURING investigations on nitrogen-containing materials synthesized by moulds, we have isolated, in high yield, from the mycelium of *Penicillium puberulum* Bain, a hitherto undescribed organic substance as substance, which exists in white and yellow forms, is photosensitive, analyses as $C_{17}H_{12}N_2O_2$, and melts with decomposition at 220° . Two enolic hydroxyl groups appear to be present, since reaction with diazomethane gives a dimethyl derivative, m.p. 181° (decomp), which contains no N-methyl groups. This material crystallizes in two interconvertible forms, either as yellow needles or as orange-brown plates, from acetone. Acetylation of the original substance with acetic anhydride and pyridine yields a diacetyl derivative, m.p. 226° (decomp). On heating, the original substance yields an enol, and oxidation gives *p*-hydroxy-benzoic acid. Oxidation of the dimethyl derivative with permanganate yields hydrogen cyanide, anisic acid and other unidentified products, and heating with sodium ethoxide in methyl alcoholic solution gives ammonia, anisic acid and other products. Both the original substance and its acetyl and dimethyl derivatives give blue-violet fluorescent solutions and possess characteristic absorption bands. The original substance shows bands at $243\text{ m}\mu$ and $374\text{ m}\mu$ with $\log \epsilon_{\max} 4.08$ and 4.60 respectively in ethyl alcohol. The dimethyl derivative possesses very similar absorption spectra with bands at $240\text{ m}\mu$ and $371\text{ m}\mu$, with $\log \epsilon_{\max}$ at 4.12 and 4.54 respectively in the same solvent. The acetyl derivative has absorption bands at $232\text{ m}\mu$ and $334\text{ m}\mu$, with $\log \epsilon_{\max} 3.79$ and 4.4 respectively. In alcoholic alkaline solution the spectrum of the dimethyl derivative is unchanged, but the original substance now possesses bands at $261\text{ m}\mu$, $398\text{ m}\mu$ and $252\text{ m}\mu$ with $\log \epsilon_{\max} 4.59$, 3.98 and 4.09 respectively. The original substance has antibiotic properties, but does not appear in the mycelium until incubation has proceeded for five weeks. This aspect is receiving further attention, and other moulds are being examined for the presence of complex nitrogenous substances.

A. H. CAMPBELL

E. L. HIRST

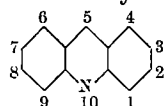
M. E. FOSS

J. K. N. JONES

The University, Bristol Dec 5

Optical Activity of Excreted Mepacrine

THE antimalarial drug mepacrine—2-chloro-5-diethylamino- α -methylbutylamino-7-methoxyacridine, acridine being numbered



has been resolved by Cholintsev and Osetrova¹, who found $[\alpha]_D = \pm 195^\circ$ for the free base and $[\alpha]_D = \pm 357^\circ$ for the dihydrochloride.

In co-operation with the Army Malaria Research Institute in Oxford, we have recovered mepacrine from human urine and find that the excreted drug is

apparently entirely the *laevo* isomer. Thus we obtain, for the free base in methyl alcohol, $[\alpha]_D = -150^\circ$ and -207° (mean $[\alpha]_D = -179^\circ$), the specimens having been separated chromatographically directly from urine on alumina. For the dihydrochloride, extracted from alkaline urine with ligroin, followed by chromatographic separation and elution with hydrochloric acid, values of $[\alpha]_D = -364^\circ$ and -372° (mean $[\alpha]_D = -368^\circ$) were obtained.

We take this opportunity to correct the naming of the degradation product of mepacrine previously reported² as sometimes occurring in human urines, the substance should be described as 2-chloro-5-amino-7-hydroxyacridine.

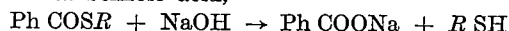
D. LL. HAMMICK

W. E. CHAMBERS.

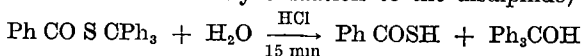
Dyson Perrins Laboratory,
Oxford Dec 23¹ *J. Gen. Chem. U.S.S.R.*, 1928 (1940)² *Nature*, 154, 461 (1944)

Hydrolysis of Thioesters

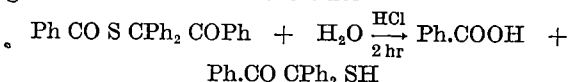
THE alkaline hydrolysis of triphenylmethyl thio-benzoate or α -benzoylbenzhydryl thio-benzoate¹ in alcoholic sodium hydroxide gave the corresponding thiol and benzoic acid,



But the acid hydrolysis of triphenylmethyl thio-benzoate (1.2 gm in 200 c.c. alcohol and 30 c.c. conc. hydrochloric acid and boiled for 15 minutes) gave triphenylmethyl carbinol and thiobenzoic acid (separated and identified by oxidation to the disulphide)



The same procedure with α -benzoylbenzhydryl thio-benzoate but with a prolonged heating for two hours gave benzoic acid and the thiol



The mechanism suggested by Davies and Evans², if applied here, should give benzoic acid and the thiol in both cases. This result also shows that in acid hydrolysis of esters the OH of water does not necessarily appear in the acid molecule³, its position seems to depend on the anionic and cationic natures of the two radicals of the ester.

Further work is being continued by Iskander and Fateen.

YOUSSEF ISKANDER.

Chemistry Department, Faculty of Science,
Farouk I University, Alexandria¹ Schonberg and Iskander, *J. Chem. Soc.*, 92 (1942)² *J. Chem. Soc.*, 444 (1940)³ Cf. *Annual Report Chem. Soc.*, 229 (1940)

Structure of Colchicine

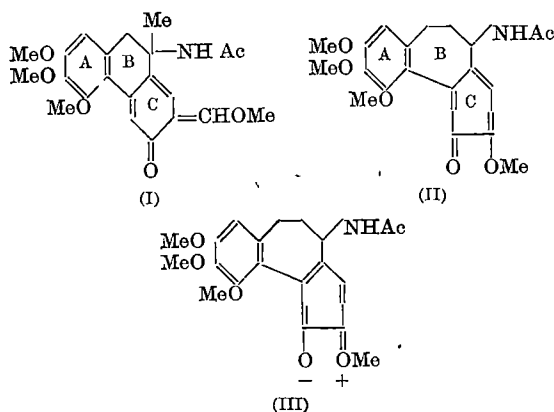
IN view of the remarkable physiological properties of colchicine its chemical nature is of some interest. Until recently, the structure (I) proposed by Windaus¹ has been generally accepted, although the stability of colchicine did not suggest a 9-amino-9,10-dihydrophenanthrene system, and although the salicylaldehyde enol structure of ring C appeared fantastic. Cohen, Cook and Roe² have now provided evidence that ring B must be 7-membered, but the exact

location of the acetamido group remains uncertain, the isolation by Windaus of 4-methoxyphthalimide from the oxidation product of acetylcolchicinol methyl ether suggested that the group was adjacent to ring *C*, but Lettré and Fernholz³ have found that only β -anisylethylamine derivatives act as mitosis poisons.

Windaus based his structure for ring *C* on the following evidence (1) Colchicine is easily hydrolysed to methanol and colchicine, which, unlike colchicine, gives an intense ferric chloride reaction. (2) Further hydrolysis gives acetic acid and trimethylcolchemic acid. Trimethylcolchemic acid forms a dibenzoate and two isomeric dibenzenesulphonates, which are hydrolysed to the same monobenzene-sulphonate. It cannot, therefore, be a carboxylic acid. Windaus thought the isomers were *cis* and *trans* hydroxymethylene derivatives. (3) With sodium hydroxide and iodine, colchicine is converted to N-acetylcolchicinol, in which ring *C* is definitely benzenoid. Similar reaction occurs with bromine water, while alkali fusion of colchicine followed by permanganate oxidation provides trimellitic acid, formed from ring *C*. (4) In alcohol, colchicine will form a deep yellow dihydrochloride, and its solutions in alkali are also yellow, salicylaldehyde shows similar behaviour.

On the other hand, it is very difficult to believe that colchicine could also have the enolic structure. It certainly is not the isomeric aldehyde, the absorption spectra of colchicine and colchicine are almost identical⁴, and colchicine is a much stronger acid than salicylaldehyde, it gives no carbonyl or aldehyde reactions. No double bonds can be detected in colchicine with maleic anhydride or perbenzoic acid⁴.

Recently⁵, it was pointed out that stipitatic acid probably contains a tropolone ring, its reactions⁶ seem closely analogous to those of ring *C* in colchicine and led to similar difficulties. The structure (II) is therefore now proposed for colchicine, resonance with (III) accounting for its stability, the system is analogous to γ -pyrone.



The facile conversion to benzene derivatives is due to benzylic acid rearrangement, analogies are provided by the Wallach degradation of cyclic ketones and the isomerization of stipitatic acid by alkali fusion. The intense ferric chloride reaction of colchicine is at once explained, and also the existence of two isomeric dibenzenesulphonyl derivatives. It is interesting to observe that Lettré and Fernholz appear to have obtained a colchicine isomer by the action of diazomethane on colchicine, although with sodium methoxide and methyl iodide colchicine is formed⁷. The formation of coloured salts with acid

or alkali is characteristic of both colchicine and stipitatic acid, also the slight colour of stipitatic acid suggests that, like colchicine, it has an absorption band in the near ultra-violet.

It is hoped to confirm the structure (II) by le tetra-acetate or analogous oxidation of hexahydrocolchicine⁴, which should on the new formula be an α -glycol. Of course, in (II) the methoxyl or keto groups in ring *C* may be interchanged, or the ring rotated about its junction with ring *B*; further degradation will be required to establish the exact orientation of the various substituents.

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University, Oxford.

¹ Windaus, *Annalen*, **439**, 59 (1924)

² Cohen, Cook and Roe, *J. Chem. Soc.*, 194 (1940)

³ Lettré and Fernholz, *J. physiol. Chem.*, **278**, 175 (1943)

⁴ Bursian, *Ber.*, **71**, 245 (1938)

⁵ Dewar, *Nature*, **155**, 50 (1945)

⁶ Birkinshaw, Chambers and Ralstuck, *Biochem. J.*, **36**, 242 (1942)

⁷ Johanny and Zeisel, *Monat.*, **9**, 873 (1883)

Extensive Penetrating Showers

Two main types of cosmic ray showers have been much investigated (1) extensive air showers (Aug showers), (2) penetrating showers. Extensive air showers can be interpreted, according to Euler and Wergeland¹, Nordheim², and Bethe³, in terms of large electron cascades. Penetrating showers are probably produced by the process which is responsible for the production of the meson component of cosmic radiation.

It has been assumed that the two types of showers are connected. Thus Wataghin, de Souza Santos and Pompeia⁴ and Jánossy⁵ have found that π meson discharges in a distant counter often occur simultaneously with the discharge of a set of counters which record penetrating showers. Wataghin⁶ and his co-workers have found showers with counters shielded with 17 cm. of lead at counter separation of 120 cm.

Auger⁷ and Hilberry⁸ have found that 5 per cent of extensive air showers can penetrate a lead absorber 10 cm. in thickness. Such a penetrating power can be expected for ordinary cascades. Rogozinsky⁹ has also demonstrated the presence of penetrating particles in air showers.

These observations have usually been interpreted on the assumption that extensive air showers are, the main, cascade showers which occasionally contain penetrating particles. From this experimental evidence and from the results of our own experiments which are reported below, we would suggest a different interpretation, namely, that extensive air showers consist of two distinctly different types of shower: (1) large electron cascades which may contain a few mesons (Auger showers), and (2) extensive penetrating showers which have a large density of penetrating particles. These penetrating particles are probably accompanied by soft secondary particles.

The experimental lay-out is shown in Fig. 1b consists of two penetrating shower sets *P* and *C* similar to those described elsewhere, and an extensive *E* which is shown in detail in Fig. 1a. The counter tray *E* has an area of 2,500 cm² and the tray *S*, which is covered on the top and the sides by a layer of lead some 15 cm. in thickness, an area of 1,000 cm². The tray consists of eight counters in two groups *S*₁ and *S*₂ of four counters each. The penetrating shower sets *P* and *C* require at least two penetrating particles

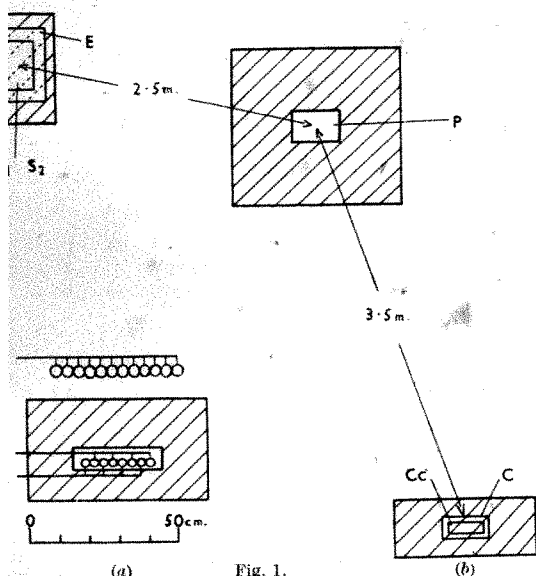


Fig. 1.

set them off. The set C is placed above and below cloud chamber Cc (Rochester¹⁰). The data presented are mainly for coincidences between the set P and extension.

The following types of coincidences have been recorded. (1) Coincidences between P and at least one of the counters in the tray E (designated PE), (2) coincidences PE accompanied by the discharge of at least one of the counters of the tray S (designated PE_S), and (3) coincidences PE accompanied by the charge of at least one counter in each group in tray S (designated PES_{12}). Thus showers of type (2) contain at least one penetrating particle at the extension, while showers of the type (3) contain at least two penetrating particles at the extension. The observed rates are given below:

EXTENSIVE AIR SHOWERS CONTAINING AT LEAST TWO PENETRATING PARTICLES NEAR P AND AT LEAST n PENETRATING PARTICLES NEAR THE EXTENSION.

	$n = 0$ (PE)	$n = 1$ (PES)	$n = 2$ (PES_{12})
Rate per hour	0.10 ± 0.008	0.024 ± 0.004	0.011 ± 0.003

The rate of coincidences P , found from a separate experiment, is 0.24 c.p.h.

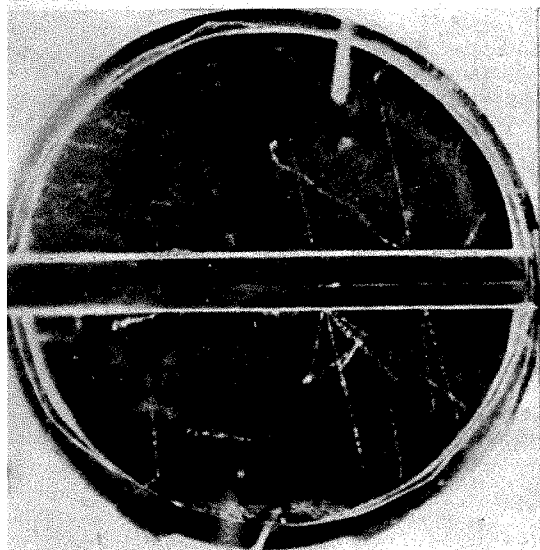


Fig. 2.

To produce coincidences PES_{12} , at least four penetrating particles are required. The probability that a shower of only four particles will simultaneously discharge counters in the P set and in the trays E and S_1 and S_2 is, however, extremely small. It is, in fact, so small that if all the mesons falling on an area of 30 m.² around P and E consisted of showers of four mesons, the total number of such showers would still be far too small to account for the observed rate of extensive penetrating showers. Thus the density of the showers must be very much greater than four penetrating particles per 30 m.². An estimate of the lower limit of the density can be obtained by comparing the rate of coincidences PES with those of the type PES_{12} . It is concluded that the showers contain about twenty penetrating particles per m.², so that the number in the area 30 m.² will be about six hundred.

It will be shown elsewhere that penetrating showers of this size and density cannot be accounted for in terms of meson production by photons or electrons in large showers.

Extensive penetrating showers cannot be accounted for in terms of the theory of Hamilton, Heitler and Peng^{11,12}. According to this theory, groups of about ten mesons are to be expected whenever a fast nucleon traverses a nucleus. The mean-free-path of a fast nucleon in air much exceeds 100 m. Thus meson showers will be produced only rarely at distances smaller than 100 m. from the recorder. Showers containing about ten particles starting at such distances have an extremely small probability of setting off the recorder. Other processes giving rise to many more particles are therefore required to account for the observed coincidences. Such processes may include those enumerated by Hamilton, Heitler, and Peng, which become important above 10^{12} e.v.

We have obtained several photographs with the cloud chamber Cc (Fig. 1) set off by coincidences PE . Some of these photographs show single penetrating particles. One photograph (Fig. 2) has been obtained for which a coincidence PES_1 (S_1 not discharged) occurred simultaneously with a coincidence of the set C . This photograph shows two particles passing through a lead plate 2.3 cm. in thickness placed across the chamber. As both particles produce secondaries in the lead plate, the incident particles cannot have been mesons. This photograph, though not necessarily typical of extensive penetrating showers, serves to show that such showers may be complex.

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G. D. ROCHESTER.
D. BROADBENT.

Physical Laboratories,
University,
Manchester, 13.
Dec. 12.

¹ Euler, H., and Wergeland, H., *Astrophysica Norv.*, **3**, 165 (1940).

² Nordheim, L. W., *Phys. Rev.*, **59**, 929 (1941).

³ Bethe, A. H., *Phys. Rev.*, **59**, 684 (1941).

⁴ Wataghin, G., de Souza Santos, M., and Pompeia, P. A., *Phys. Rev.*, **59**, 902 (1941).

⁵ Jánosy, L., *Proc. Roy. Soc. A*, **179**, 361 (1942).

⁶ Wataghin, G., de Souza Santos, M., and Pompeia, P. A., *Phys. Rev.*, **57**, 339 (1940).

⁷ Auger, P., Ehrenfest, P., Maze, R., Daudin, J., Robley, A., and Fréon, A., *Rev. Mod. Phys.*, **11**, 288 (1939).

⁸ Hilberry, N., and Hilberry, A. H., *Phys. Rev.*, **61**, 393 (1942).

⁹ Rogozinsky, A., *Phys. Rev.*, **65**, 291 (1944).

¹⁰ Rochester, G. D., *Nature*, **154**, 399 (1944).

¹¹ Hamilton, J., Heitler, W., and Peng, H. W., *Phys. Rev.*, **64**, 78 (1943).

¹² Jánosy, L., *Phys. Rev.*, **64**, 345 (1943).

Are there Four Possible Diamond Structures?

SIR C. V. RAMAN has recently¹ made the suggestion that four different crystal structures of diamond exist, in which the carbon atom positions are similar, but in which the orientations of the tetrahedral carbon atoms in the two interpenetrating face-centred lattices differ. Two of these structures are tetrahedral, two octahedral; Raman suggests that type I diamonds consist of either of the tetrahedral forms, or of both interpenetrating (the deviation from the 'ideal' crystal increasing with interpenetration), and that type II diamonds consist of either or both of the octahedral forms; mixtures of tetrahedral and octahedral forms, he suggests, may also exist.

This is a startling theory, for it implies the existence of a number of allotropic forms of all crystals of carbon compounds; but Raman supports his theoretical speculations with a wealth of interesting experimental evidence. His claim, however, that "X-ray findings leave the question whether diamond possesses tetrahedral or octahedral symmetry entirely open" cannot be left unchallenged. In the two *tetrahedral* structures postulated, the carbon atoms having co-ordinates 000, $\frac{1}{4}\frac{1}{4}\frac{1}{4}$ are similar in orientation and there should therefore be no second-order reflexion from the octahedral plane. In any mixture of these structures, whether on a basis of time or space, the 222 reflexion must similarly be absent. In the two *octahedral* structures the atoms at 000, $\frac{1}{4}\frac{1}{4}\frac{1}{4}$ differ in orientation, and a weak 222 reflexion is to be expected.

The existence of a real (Bragg) 222 reflexion is not easy to demonstrate. It may be masked by the Renninger effect² (an effect due to multiple reflexion in the crystal, which produces apparent reflexion from planes which really cannot reflect at all, and which may enhance or diminish the reflexion from those that can), and it might be simulated by a vibration of the atoms that would disturb the 3:1 spacing relationship in the octahedral planes. In 1937, Renninger himself showed, however, that three diamonds of a wide range of texture all gave a real 222 reflexion in orientations where the Renninger effect could not occur³. One of his diamonds was a magnificent natural octahedron, the description of which classes it without doubt as an almost ideal type I. This gave a half-width at half-maximum 222 copper $K\alpha_1$ reflexion which was about one twelfth of the $\alpha_1 - \alpha_2$ separation, clear proof that it was a true Bragg reflexion from an almost perfect crystal.

I have examined a beautiful, water-white octahedral plate from Sierra Leone, kindly lent to me by Prof. W. T. Gordon; almost non-luminescent in ultra-violet light; blue-luminescent in X-rays; opaque beyond 3000 μ ; optically isotropic; giving intense groups of 'extra' X-ray reflexions and showing no divergent-beam photograph at all; it is obviously a near-ideal type I specimen. This gives a definite 222 reflexion in an orientation which forbids a Renninger effect, and the nature of the reflexion shows that it cannot be due to atomic vibration⁴. It proves conclusively that the structure is *not* tetrahedral, but that a real variation of orientation exists between carbon atoms in the 000, $\frac{1}{4}\frac{1}{4}\frac{1}{4}$ positions.

On the X-ray evidence, therefore, Raman's theory, that type I diamonds are essentially *tetrahedral* in structure, breaks down. It may also be noted that

the 'tetrahedral structure' theory offers no explanation whatever of the peculiarities of the 'extra' flexions, particularly for {220} {113} and {331}, type I diamonds⁵.

Dr. R. S. Krishnan⁶ has supported Raman's theory that type II diamonds showing strong refringence are really mixtures of *two distinct octahedral* structures, by suggesting that in such diamonds 'lattice constant' variations exist, of the order 1 in 2,000. He states that my divergent-beam precision measurements of the diamond spacing⁷ give only a mean value, and could not distinguish the existence of such variations. This is not so. The sharpness of the absorption lines in my photograph (particularly for the high-order reflexions) shows that in the type II specimens used, the lattice constant did not vary by more than about 1 in 50,000, except possibly in regions so small as to give no observable X-ray effects. Krishnan bases his suggestion of 1 in 2,000 spacing variation on the experimental fact that when a particular, optically anisotropic, lamellated type II diamond was correctly orientated for X-ray reflexion from the octahedral plate surface the 111 reflexion recorded on a photographic film some 40 cm. away was wavy instead of linear, the showing apparent variations in the value of θ , the reflecting angle. But this is a common phenomenon and is capable of an altogether different interpretation. A slight distortion, in this case a corrugation of the crystal surface, would cause an ex-centring of parts of the reflecting regions relative to other parts, quite sufficient to cause the observed waviness of the reflexion line.

There is a simple way of testing whether an apparent variation in spacing is real, or is due to ex-centring of parts of the reflecting surface. Diamond gives some fairly intense high-order reflexions; and if these are examined, *crystal distortion* will give an angular variation of the same order as, or less than that found for low-order reflexions; but a *variation in spacing* would cause a much wider variation in reflexion angle. For example, the angular variation in θ_{111} (copper $K\alpha_1$) corresponding to a lattice variation of 1 in 2,000 would be only 0.7 minutes; for θ_{331} (copper $K\alpha_1$) it would be 4.8 minutes; and for θ_{324} (zinc $K\alpha_1$) it would be 10.1 minutes. I have taken divergent-beam photographs of type I diamonds which give wide absorption lines, using copper K radiation. If the width were due to lattice spacing variation, the high-order absorption line would be much wider than the low-order lines, but they are, in fact, not so wide. It is quite clear in the case of those diamonds that I have tested, that when distortion may sometimes occur, there is no X-ray evidence, on the basis of lattice constant variation for the existence of the various structures postulated. The variation of the *texture* of the diamond, from ideal to mosaic, is of course a common feature of crystals generally^{8,9}.

KATHLEEN LONSDALE.

Royal Institution, Albemarle Street,
London, W.1. Dec. 11.

¹ Raman, Sir C. V., *Current Science*, **12**, 33 (1943); *Proc. India Acad. Sci.*, **19**, 159, 199 (1944). [See also *Nature*, **155**, 69 (1945).]

² Renninger, M., *Z. Phys.*, **106**, 141 (1937).

³ Renninger, M., *Z. Krist.*, **97**, 107 (1937).

⁴ Lonsdale, K., *Nature*, **149**, 402 (1942).

⁵ Lonsdale, K., *Proc. Roy. Soc., A*, **179**, 315 (1942).

⁶ Krishnan, R. S., *Proc. Indian Acad. Sci.*, **19**, 298 (1944).

⁷ Lonsdale, K., *Nature*, **153**, 22 (1944).

⁸ Renninger, M., *Z. Krist.*, **89**, 344 (1934).

⁹ Lonsdale, K., *Nature*, **153**, 433 (1944).

British Bees and Wind-borne Pollen

It is well known that the perianth in wind-illuminated plants is lacking or greatly reduced and conspicuous, that nectar-secreting glands are absent and that immense quantities of pollen are produced compared with entomophilous flowers. Furthermore, the individual pollen grains are more suited to carriage by wind, with their thinner walls and simpler form lacking spines or surface sculpture. They have a markedly lower specific gravity and do not cohere in masses like those of insect-fertilized flowers. It is therefore rather surprising to find that solitary bees of the genus *Andrena* sometimes collect large quantities of anemophilous pollen, for example, *Quercus*, *Fagus*, *Castanea*, as the analyses per cent of individual pollen loads taken off the species named below demonstrate

<i>A. haemorrhoea</i> (Fab)			
	1	2	3
<i>Quercus</i>	83	<i>Fagus</i>	82.2
<i>Pinus</i>	8	<i>Taraxacum</i>	13.0
<i>Castanea</i>	6	Cruciferae	3.8
<i>Salix</i>	3	Others	1.0
<i>A. armata</i> (Gmelin)			
	4	5	6
<i>Quercus</i>	90.6	<i>Quercus</i>	56.3
<i>Pinus</i>	9.4	<i>Acer</i>	28.6
		<i>Salix</i>	13.2
		Others	1.9
<i>A. pubescens</i> Oliv			
	8	9	
<i>Fagus</i>	51.1	<i>Fagus</i>	26.8
<i>Taraxacum</i>	21.1	<i>Acer</i>	53.6
<i>Heracleum</i>	14.3	<i>Taraxacum</i>	17.4
<i>Prunus</i>	11.7	<i>Salix</i>	1.6
Others	1.8	Others	0.6
<i>A. bimaculata</i> (Kirby) (2nd brood)			
	10	11	12
<i>Castanea</i>	99	<i>Castanea</i>	61.4
<i>Pinus</i>	1	<i>Spiraea</i>	34.4
		<i>Rubus</i>	4.2
		13	
		<i>Castanea</i>	78.1
		<i>Spiraea</i>	21.9

In addition, pollen loads containing high proportions of *Quercus* pollen have been taken off *A. jacobae* Perk, and of *Castanea* pollen off *A. dorsata* (Kirby) and *A. thoracica* (Fab).

The factors governing the choice of flowers visited by bees are probably numerous, even the extensive investigations on the hive bee (*Apis mellifera* L.) have led to few definite conclusions. Consideration of the results tabulated above raises several interesting queries.

In the first place, dealing with examples (7) and (10) how do the bees manage to carry a practically pure load of poorly cohering *Quercus* or *Castanea* pollen diluted with only a small proportion of more sticky pollen from nectariferous flowers? In the hive bee, where separate journeys for nectar or pollen are normal, the pollen-carriers moisten the pollen with nectar to assist carriage, thus involving an appreciable number of visits to nectariferous blooms. It is difficult to imagine this being done without picking pollen from these flowers as well.

Secondly, what factors are responsible for diverting the bees from their normal pollen sources for tall trees with inconspicuous nectarless flowers, which, in the case of *Fagus* and *Quercus*, are very much screened by foliage? The remaining pollen species in the loads analysed are derived from low herbs or shrubs which have conspicuous flowers or are rich sources of nectar or both, and all were in sufficient abundance in the neighbourhood of the colonies from which the bees were taken upon their return. The kind of anemophilous pollen is not normal in

A. haemorrhoea, *A. armata* and *A. pubescens*, as only 4, 5 and 3 loads containing appreciable quantities have been found among totals of 42, 33 and 36 loads analysed respectively. The catkins of *Castanea* are much more conspicuous than those of *Fagus* and *Quercus*, which may partly explain the frequent occurrence of this pollen species as a major constituent of loads of *A. bimaculata* taken in localities where this tree abounds. It should be noted, however, that *Castanea* has previously been classified as entomophilous².

A possible explanation for the taking of *Fagus* and *Quercus* pollen by *Andrena* may be as follows. When the tree is in full flower and immense quantities of pollen are being liberated, it is reasonable to suppose that an atmospheric pollen concentration gradient will be set up around the tree, with a direction and rate of decrease in concentration depending upon the wind. A bee flying into this 'pollen field' will make a chemotropic response to the floating grains, and will orientate itself in the general direction of increasing pollen concentration and travel up the gradient until it arrives at the pollen source. Where the concentration of atmospheric pollen is low or uniform, the bee will make no directional response.

Although this suggestion can only be regarded as speculation until evidence based upon carefully chosen series of observations is available, the following experience may have some bearing upon it. A colony of *A. barbitalabris* (Kirby) situated in a large plantation of Scots pine (*Pinus sylvestris*), in flower during the flight period of this species, was studied in 1943 and 1944. In the 83 pollen loads examined, *Pinus* was found only in negligible traces, the bees collecting pollen from nectariferous plants several hundred yards distant from the colony. Setting aside the possibility that *Pinus* pollen may be distasteful, upon the hypothesis put forward, the presence of a high but uniform atmospheric concentration of this pollen from the dense mass of trees had no orientating effect upon the bees' flight.

I hope to publish in due course detailed analyses of pollen loads of *Andrena*.

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¹ Weiss, H. B., *J. Econ. Ent.*, **36**, 1 (1943), a review.

² Hilde, H. A., and Williams, D. A., *New Phytol.*, **43**, 49 (1944).

Transmission of Kala-Azar to the Pouch Young of the Common Australian Possum (*Trichosurus vulpecula*)

KALA-AZAR is difficult to transmit to laboratory animals, with the exception of the hamster (*Cricetus griseus*). This rodent, however, is not available in many countries.

Recently, through the courtesy of Dr G. A. H. Heydon, School of Tropical Medicine, Sydney, a culture of kala-azar on N.N.N. medium was obtained, which was injected intraperitoneally into a pouch young of *Trichosurus vulpecula* about 2½ months old. The young, which at the time was practically hairless and still firmly attached to the nipple, was lifted out of the pouch of the anaesthetized mother, injected with 1 ml. of the broth washings of the culture tube and replaced into the pouch. One month after the injection, the young, still only covered by hairs

about 1-2 mm long, was found to be leaving the pouch at periods.

Seven weeks after the injection, the young was found to weigh 180 gm which, compared with other young of approximately the same age, was at least 30 per cent below normal. Also the abdomen was somewhat distended, and the fur was short and sparse and remained like this until the experiment was terminated. Ten weeks after the injection of the culture of kala-azar, the animal was markedly undersized, frail and weak, though still eating and moving about freely. Its abdomen was markedly distended, and on palpation an enlarged liver and spleen could be felt. The possum now weighed 390 gm. It was anaesthetized with ether, and blood was obtained by heart puncture. A few minutes after this the animal died suddenly. An immediate autopsy showed a greatly enlarged spleen which had a mottled appearance, and on cross-section large whitish nodules were seen. It weighed 8.9 gm. This is at least five times the normal weight for an animal of this size. The liver, which was greatly enlarged, was pale but contained numerous small diffuse, haemorrhagic areas. It weighed 26.2 gm. The left and right kidney weighed 3.4 gm and 3.2 gm respectively. A blood count showed a marked microcytic anaemia with a colour index of 0.69. There were 22 nucleated red cells per 100 leucocytes and a marked neutropenia (4 per cent). A smear made from the pulp of the spleen contained numerous Leishman-Donovan bodies particularly in the cytoplasm of the monocytes. The parasites were also seen in sections of liver and bone marrow. In cultures prepared from spleen, sternum and blood, the flagellate form of the pathogenic protozoon could be seen.

The mother was killed some three weeks after the death of its offspring, and no evidence of infection could be found at autopsy in the spleen, liver, bone marrow or blood.

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A Wasp Preying on House-Flies and Stable-Flies

Rubrica surinamensis (DeGeer) is a large and striking neotropical wasp belonging to the family Bembicidae. Its geographical range extends from the Argentine to Trinidad. It is commonly found nesting gregariously in a semi-social manner with other individuals in areas of bare sandy ground exposed to the sun. Flies of many different families comprise the prey. The flies captured are stung to death and used for provisioning the nest, the developing wasp larva being fed progressively from day to day.

In Trinidad this wasp normally preys upon horse-flies and hover-flies. However, other species of flies, including the house-fly, *Musca domestica* L., and the stable-fly, *Stomoxys calcitrans* (L.), have been observed on occasion to comprise the prey.

The wasp apparently exploits any readily available source of prey. Nests examined were sometimes found to contain the remains of many different kinds of flies. At other times only a single species was represented in the prey.

Wasps carrying house-flies were caught at the entrance to their nests. On digging up one such nest, a partly-grown wasp larva was found together with three intact house-flies and the remains of others. Other individuals bearing stable-flies were similarly captured. In this case the abdomen of the prey was frequently greatly distended with blood. On releasing such wasps, they returned after a few minutes with other stable-flies, also gorged with blood. This was repeated a number of times. Apparently these individuals were utilizing a supply of stable-flies feeding presumably on livestock. The nest of one such wasp on examination was found to have been provisioned entirely with stable-flies.

As few natural enemies of either the house-fly or the stable-fly are known, it is thought to be of sufficient general interest to place the above observations on record.

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A Colonial Scientific Service

In the concluding remarks to his article¹ *Anopheles gambiae* in America, my old friend and colleague, Dr John Smart, of the British Museum (Natural History), suggests that men engaged present on anti-malarial or other entomological work with the Forces may be engaged after the War to continue work of this kind in the Colonies and elsewhere.

I have served in the Colonial Empire both as a scientific worker and as an administrative officer, and I believe the time will be ripe after the War for inaugurating a 'Colonial Scientific Service' or possibly even more than one scientific service, including perhaps a Colonial Biological Service. At any rate, such a scientific service would have its own departmental head (or heads), who would be responsible for the seconding of personnel to wherever they were wanted and to appropriate work. The departmental head would also be able to put together teams of scientific workers for attacking several problems from necessary different points of approach in co-operation.

It may be said that those men of science who work in the already existing Colonial departments and the few scientific specialist departments (such as for example, as the Tsetse Research Department Tanganyika) have already accomplished work of such value that no change is needed to improve the quantity of individual work by scientific workers in the Colonies. I should not disagree with such a view, but I think that the proposition of a Colonial Scientific Service or Services bears careful consideration from two points of view.

First, there is unnecessary divergence and consequent loss of efficiency due to the same problem being attacked in different Colonial territories by differently qualified personnel approaching it from different preconceived ideas of attack, as it were. To make this clear, let me again quote the very fine work done by the Tsetse Research Department Tanganyika during some years, in the neighbouring Colony of Kenya, where tsetse work is done entirely by the Veterinary Department, and the officer who is devoted entirely to this work at present is not an entomologist, but a veterinarian. In Nigeria again, tsetse work is carried out by the Medical

partment. In Uganda, also, tsetse work was until comparatively recently carried out by the Medical department. It is inevitable that to some extent such a variation in departmental authority over the same type of work in different territories must result in lack of co-operation and of a common policy, and overlapping and duplication of work.

Secondly, there is the more human aspect of the position of the pure scientist in 'professional' or non-scientific Government departments. As I pointed out in an article published in South Africa this year: "Except for some medical entomologists, the rule is that the scientist is treated as inferior in every material respect (salary, pensions, quarters, ship accommodation, etc.) to 'professional' men. Clearly it is undesirable that scientists cannot work with 'professionals' as equals in scientific spheres, as it leads to resentment and lack of co-operation."

There are some scientific workers, whose experience as generally been largely academic, who would say that such observations show a mean spirit and a pre-occupation with money and material things. I have the greatest respect for this view and for some of its holders, who are in some cases older and have greater experience than I; and it is, in fact, an idealistic view with which I am temperamentally entirely in sympathy. But I think it is hard, if not impossible, for those who have not worked in India or the colonies to realize just how much these small financial and social distinctions may mean in the lives of isolated communities of Europeans where the coloured folk and a great many 'whites' adjust their reaction to a nicety to each person, depending on his position on the 'staff list', his income, and outward signs of material prosperity and social status. In Tanganyika, a Government officer is allowed twenty-five porters on any day on 'foot safari'; only the rawest greenhorn could ever take less, even if half of them were carrying nothing—for chiefs and others immediately assess a man with only a few porters as a 'stiff' or 'oor white', and his way is made harder in getting food, water, directions and a hundred and one small but important ways which loom very big indeed in the 'Blue'. I know that we colonial Europeans probably go too far in our social attitude to position (because of this environment in which we have lived and often struggled) with so much awareness of how every minute of the day we were being socially weighed up and our paths made appropriately smoother or rougher; but I think also the stay-at-home and the European who knows the 'Blue' only from expeditions errs a little at the other extreme

in attaching no importance to these apparently trivial and worldly matters. The fact that a field biologist, for example, has to travel second-class by train in Kenya (unless he pays part of his own fare) while a veterinary officer goes 'first' makes an incredible amount of difference to the attitude of the five inhabitants to each; particularly as some non-Europeans always travel 'second' but seldom 'first'. I am not condoning this common native attitude—merely stating it.

It is only natural also that the 'specialist' should more often than not be passed over in Government departments when senior posts fall vacant. There are exceptions, such as that of the head of the Sudan Agricultural Department, who is an entomologist: in many cases on the other side could be quoted. I will give two only. The senior medical officer of a province in Tanganyika is in charge of a lunatic asylum for the whole territory. He has not specialized

in mental cases, but was a pathologist in Nyasaland. This was his first chance of promotion—and promotion implied getting out of the blind alley of specialization. The chief veterinary entomologist in Kenya has worked in that Colony for more than fifteen years, but is paid less than a veterinary officer of comparatively junior standing.

If it is possible to have a Colonial Scientific Service (or Services) with its own head (or heads) who will second scientific men to where they are needed, this difficulty of the specialist being in effect often barred from high promotion would be removed, for every member of the scientific department or departments would then have an equal chance of promotion to the highest grades within his own department or departments. The outstanding example of such a method which has achieved such conspicuous success is, of course, the Tanganyika Tsetse Research Department. The success of the late Mr. Swynnerton in building up a colonial scientific specialist department may induce serious consideration of whether it is not a very worthy example to be followed.

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¹ Smart, J., *Nature*, 153, 765 (1944).

Sir Charles Boys

SINCE it was my good fortune to know Sir Charles Boys intimately during the last fifteen years or so, perhaps I may be permitted to add a word or two to the obituary by Prof. C. T. R. Wilson in *Nature* of January 13 about his great originality in everyday life. He was certainly original and unconventional in openly attributing any portion of his great success to his former *schoolmaster*, and I would further add that many was the time that Boys spoke to me of G. F. Rodwell, the first science master at Marlborough College, and his methods.

Boys also endeavoured to contribute to the science teaching at Marlborough, for not only did I return many times from visiting his home at St. Marybourne with my car weighed down with literature and apparatus, but also some ten years ago Boys had the two gold medals presented to him by the Royal Society photographed and then melted down. The photographs were framed and hung in the laboratories, and the money from the gold was given to establish a prize for experimental work in science.

At school Boys was certainly unconventional, for he confided to me that he took the College book of rules and broke every one of them in order. "I never stole or did anything criminal, but short of that there was not a rule I left unbroken," is what Boys told me on more than one occasion. Boys completely stripped the College clock and replaced the parts so effectively that the clock suddenly took on a new lease of life; the secret was not divulged until many years later. This job took Boys several weeks. Here we get some slight insight to the wonderful patience of Boys as a boy—that patience which enabled him to wait twenty-eight years for his first successful photograph of a progressive lightning flash.

Truly Boys was always Boys.

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TISSUE INDUCTION

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IN a regeneration there always originates from a causal point of view the question: Is the new tissue developed merely from pre-existing cells, which grow out from the original cell-units, or may also some other material be imagined as participating in the occurrence of regeneration? In the latter case, it is necessary to explain how an initially unspecific tissue is able to develop in a specific direction.

For several years I have been studying the healing of bones, especially from a causal-genetic point of view. At present, there are two doctrines which in different ways try to explain the regrowth of the bone tissue, namely, the specific osteoblastic theory and the metaplastic theory. According to the former, there are within the soft parts surrounding the skeleton—the periosteum, the marrow and the content of the bone canals—young bone cells which in the case of fracture grow out into the surroundings and there develop into completed bone tissue. In evidence of the correctness of this opinion are quoted first and foremost tests which show that isolated bits of the different skeletal layers after transplantation into non-osseous surroundings give rise to the formation of new bone. However, no careful or thorough morphological analysis of the reactions of the tissue has been made. It has simply been taken for granted that when bone formation is obtained, this must have emanated from transferred bone cells. This mechanism, however, seemed to me less probable. In the transplantation of a tissue, we must also expect that the cells of the graft in the new surroundings will not have the same favourable possibilities of growth, but will encounter a certain resistance in all those cell reactions and exudations which occur at the place of transplantation, and which tend to remove all those elements which are foreign in the physiological sense.

I have therefore carried out several transplantation tests with the different skeletal layers—periosteum¹, hard tissue² and bone-marrow³—into soft parts. In contradistinction to previous investigators, who as a rule have made observation over a long period in

such tests, I considered it to be of importance at very early stage—one or two days after implantation—to follow the reactions which take place both in the graft itself and in its surroundings. The result of such experiments went to show that the implanted skeletal parts died after a brief period. In the surroundings of the graft, on the other hand, it was observed that fresh bone grew from the mesenchymatous tissue. These investigations thus gave support to the so-called metaplastic theory, according to which connective tissue can be converted into bone tissue. From a causal point of view, however, the metaplastic theory is incomplete, since no one has been able to explain why the connective tissue under certain conditions passes in a perfectly regular way into bone tissue.

On the basis of the experience from these transplantation tests into soft parts, it was clear that there must be a certain connexion between the graft and the newly developed bone tissue. The morphological analysis of the tissue showed clearly that it is impossible to explain the connexion by direct growing over of cells from the graft; for the fresh bone grew out of the newly developed mesenchymatous tissue in the surroundings. I then thought it possible that the specific factor necessary for differentiation of a unspecific surrounding might be transferred from the graft to the surroundings as some substance. This substance should be capable of extraction from the bone tissues. In order to examine this hypothesis I prepared an extract of bone tissue with alcohol and injected it by a special method into the muscle. In 24 per cent of cases growths of cartilage and bone were obtained⁴ (Fig. 1). Control tests with alcoholic extract of other tissues only were negative. The tests with the injection of an alcoholic, non-cellular bone extract have since been confirmed by Annersten and by Bertelsen⁵, who obtained cartilage or bone development in 20–50 per cent of their tests. The tests with bone extract free from cells thus go to show that a tissue within the fully developed organism is able to influence another in specific differentiating direction by means of an extractable substance.

It became, then, of interest to see how far the tissue reaction had any general validity. Transplantation tests with striated muscles showed the same results as similar tests with bone tissue⁶. On injection

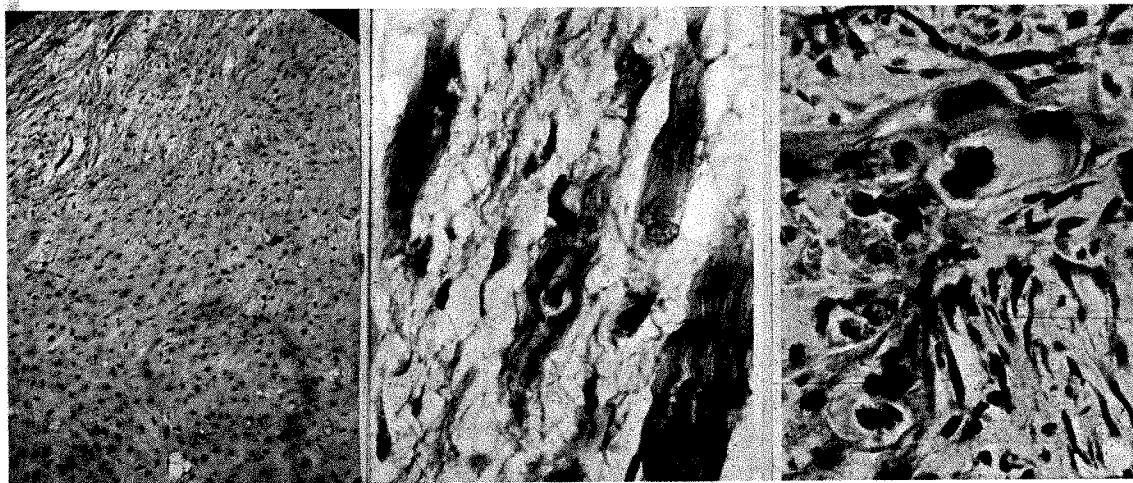


Fig. 1. CARTILAGE IN FORMATION AFTER INJECTION OF BONE EXTRACT.

Fig. 2. YOUNG MUSCLE FIBRES GROWING FROM A MESENCHYMAL TISSUE.

Fig. 3. ENDOMETRIUM CELLS GROWING IN MESENCHYMAL TISSUE.

cohol into the muscles, an abundant development mesenchymatous tissue is obtained around the muscle fibres more or less degenerated by the action of the alcohol. At the same time, one gets a plentiful generation of muscular tissue. On a closer examination of these pictures, it is seen without difficulty that the newly developed muscles not infrequently grow in such a way that they cannot be imagined as having grown from old, pre-existing muscle fibres, but like the transplantation tests, must have developed directly from a mesenchymatous source (Fig 2). I have furthermore tested the uterine mucous membrane (endometrium)⁸. It is well known in medicine how the uterine mucous membrane is found also outside the uterus, preferably around ovaries and ducts, but also anywhere within the abdomen—so-called endometriosis. Endometriosis has also been encountered in the muscles of the extremities. These findings are, of course, in favour of endometriosis being caused rather by a substance which activates mesenchymatous tissue than by dissemination of disrupted cell units. Transplantation tests with the endometrium, like those with bone and muscle, also support this conception (Fig 3). In all these transplantation tests, I have never found any mitotic developments likely to explain the specific new developments.

The circumstance that a tissue is able to affect either in a specifically differentiating direction I have termed 'induction'—a term borrowed from embryology, introduced, as is well known, by Semmann and his school at the turn of the century. In embryology one speaks about an organizer or a stem of action that induces, and a reacting stem which is being induced. According to Semmann, induction takes place by way of chemical substances. The opinion is held that the induction takes place at the moment the development of the embryo takes place. The investigations referred to above show, however, that such is not the case. In the fully developed organism, too, a specific differentiation may take place inductively at all ages. The similarity between the embryonal reactions and, by way of example, the implantation tests during the post-fœtal existence is clear. The graft in the fully developed organism corresponds to the embryonal organizer or activator, and the newly developed mesenchymal tissue at the place of implantation, which can be influenced by the graft in a differentiating direction, to the embryonal reactionary stem. The post-fœtal presence of the induction mechanism thus means from the point of view of the principle that the fully developed tissue comprises

at least two components—a specific and an unspecific factor. Extraction tests with bone tissue show that the specific factor can be released from the tissue and dissolved in certain extraction fluids. This supports the view that the specificity of the tissue is confined to certain chemical substances. If in tissue generation we find that the unspecific mesenchymal tissue is developed in different directions, we must assume that these chemical substances are able to activate the unspecific mesenchymal blast into specific differentiation. Also in embryology there prevails, as is well known, the idea that the induction is transmitted by certain substances, and a vast amount of work has been devoted to attempts to isolate these substances. No definite results appear, however, to have been reached for the present. According to Sedham and Waddington, these substances would seem to belong to the steroid group. Annersten

has obtained active extracts with fat-dissolving extraction agents. Since it seems that the same mechanism is active within both the fœtus and the fully developed organism as regards the explanation of growth, we are able to get a more comprehensive view of the development of tissues. There is every reason to assume that the same chemical substances are active both during the embryonal differentiation and during post-fœtal growth. Regeneration of tissue is, in other words, a repetition of embryonal development.

¹ Levander, G., *Acta Chir Scand*, 83 (1939)

² Levander, G., *Surg Gyn and Obst*, 67 (1938)

³ Levander, G., *Acta Chir Scand*, 83 (1940)

⁴ Levander, G., *Surg Gyn and Obst*, 67 (1938)

⁵ Annersten, S., *Acta Chir Scand*, 84, Suppl. 60 (1940)

⁶ Bertelsen, A., *Acta orthop Scand*, in the press

⁷ Levander, G., *Arch Klin Chir*, B, 202 (1941)

⁸ Levander, G., *Arch Klin Chir*, B, 202 (1941)

TUNGSHAN OCEANOGRAPHICAL SURVEY IN 1941

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A FIVE-YEAR plan for oceanographical survey along the coast of Fukien was laid down in 1941 by the Department of Oceanography, China Institute of Geography, Pei-Peh, Szechuan, in co-operation with the Weather Bureau of Fukien, Yungan, Fukien. The purpose of such a survey is to give a complete picture, with the help of scientific knowledge, of coastal waters off Fukien. This investigation is expected to be a great help in the development of agriculture and fisheries. It may also be of benefit to the Salt Administration.

According to the plan, work has to be done systematically from south to north, along the coast, and this was started from Tungshan Island from 1941 onwards. The Tungshan Survey was made from the middle of September to the end of December 1941 by the Department of Oceanography in co-operation with the Weather Bureau of Fukien.

Workers engaged in the last survey were Dr S F Tang (oceanography and fisheries), Dr T Y Ma (geology), Mr Y Chen (geography), Mr K M Lin (physics), and Messrs T M Chen and T T Young (meteorology). The first three were from the China Institute of Geography, Mr Lin from the Research Academy of Fukien, Yungan, and the last two from the Weather Bureau of Fukien.

During the survey, observations on temperature, colour, transparency and specific gravity of the seawater at each station were taken continuously for a period of twelve hours. Tides and currents at each point were carefully measured. Readings were taken every five minutes for a period of more than a day for the tide, and every half an hour for half a day for the current. Specimens of corals, shells, sea animals and seaweeds were comprehensively collected and preserved, and meteorological data were simultaneously taken. This work has been continued by the observatory station which was then established in Tungshan city.

Tungshan Island is situated in lat. 23° 32'–45' N and long 117° 20'–32' E, and lies off the border

between Kwangtung and Fukien Provinces. Its length from north to south is twenty-two miles, and its width from east to west is eighteen miles, a channel separates the northern part of the island from the mainland and connects Tungshan Harbour on the east with Chaoan Bay on the west. Tungshan Harbour is a fishery port, and Chaoan Bay is of importance for its saltworks. Fishing and salt-making enrich the islanders much more than the rice fields do the farmers on the mainland, though the lack of fresh water deprives the islanders of farming. As the results of warfare at sea, off-shore fisheries have practically disappeared. On the other hand, salt manufacture, because of the encouragement given by the Central Government and the increase of salterns and labourers, has been tremendously developed during the last five years.

It is to be noted that Tungshan is an important fishery centre in Fukien Province, and Tungshan Harbour is a very useful port along the south-west coast of China. Both as biologists and fishery investigators, we want to know the natural conditions of the fauna and flora in Tungshan waters, since these will give precise knowledge as to the position of the intermediate zone, biologically speaking, between the tropical and the temperate seas. From the practical point of view, such general biological knowledge will lead us to more accurate conclusions as to fish migrations.

Tungshan Harbour is mid-way along the Amoy-Swatow sea route, and affords merchantmen and fishing vessels a very convenient shelter during the typhoon season. However, the nature of the tides and currents in Tungshan Harbour is not yet known, as the necessary observations have not been made.

Several papers have been published upon the last survey, both at Chungking and at Yungan, by the China Institute of Geography. I have prepared two papers: "The Tides and Currents around Tungshan Island" and "The Semi-daily Variations of Salinity in Tungshan Waters".

In the first of these, I have shown that the tides and currents around Tungshan Island are of the semi-diurnal type, and that the salinities of Tungshan waters are variable.

The second paper can be summarized as follows:

1. The salt-content of the waters around Tungshan Island, especially along the northern part, varies considerably in a day. The greatest range, from 23.20 to 31.40‰, was recorded in the water of Tungshan Channel, and the periodicity of the variation was found to be semi-diurnal.

2. It appears that around Tungshan Island the variation of salinity follows exactly the movement of the tide, that is, when the tide rises and the current is inward, the salinity of the water increases, when the tide recedes and the current is outward, the salinity of the water decreases.

3. The salinity of Tungshan waters was found to reach the highest point generally half an hour before high water, as the salt-water at the time of high tide has already been covered on the surface by a layer of brackish water which comes down from up-stream.

4. Considering the Tungshan waters as a whole, the highest salinity recorded was 33.03‰, the average was 28.12‰, and the lowest was 21.92‰. The difference of 5‰ between the highest and the average means that the water of high salinity may produce one-fifth more salt than that of the average salinity which is generally used by the salt-makers of Tungshan Island.

5. The best sea-water for filling up the reservoir of the salterns around Tungshan Island can therefore only be obtained during the period from three hours to half an hour before high water, and the best days for filling up is the day following the new and full moons in each month.

ROLE OF ISOLATION IN THE DIFFERENTIATION OF PLANT SPECIES

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THE differentiation or origin of species depends upon the development of discontinuities (gaps) in the variation pattern of Nature. We recognize species not because of the amount of difference between their most divergent individuals, but because of their distinctness from each other, or the breadth of the gap between them. The formation of the gaps between species depends upon the development of some isolating mechanism. Many different kinds of isolating mechanisms are found in Nature. In order to understand the forces which direct evolution we must solve two major problems. These are first, how isolating mechanisms develop and become established as barriers between species, and second, what relation they have to morphological divergence, the "descent with modification" of Darwin.

As an aid to the solution of these two problems, evidence is produced from our knowledge of species and species hybrids in the higher plants to support the following five statements:

First, isolation of two groups of individuals by geographic barriers, even for very long periods of time, does not necessarily cause them to evolve into distinct species. Certain species of eastern North America have been isolated from their relatives in eastern Asia for millions of years, and yet the populations on the two continents have remained exactly like each other during these long ages. Second, if two species have become recognizably different as a result of long-continued geographic isolation, they do not necessarily become isolated by genetic barriers also. Some American species, such as the American sycamore (*Platanus*) (British plane) and the *Catalpa*, a different in appearance from their Asiatic relative but the hybrids between them have been found (by other workers) to be fully fertile. Third, genetic isolating mechanisms, such as cross-incompatibility and hybrid sterility, do not appear suddenly, but evolve slowly as do the visible differences between species. Many plant species, as typified in the genus *Paeonia*, are in hybridization experiments partly compatible with each other or form partially sterile hybrids. Such species may be in the process of evolving barriers of interspecific sterility between each other. Fourth, genetic isolating mechanisms have been produced artificially and analysed in laboratory field experiments, but most of these mechanisms produce their effect in one or two large steps, and are transmitted in a relatively simple Mendelian fashion. On the other hand, the isolating barriers between natural species arise through the accumulation of many small steps, and are transmitted in the progeny partly sterile interspecific hybrids according to the multiple factor pattern of inheritance. Fifth,

lence from the progeny of partially sterile inter-specific hybrids in *Apocynum*, *Galeopsis*, and *za* indicates that there is no direct genetic connection between the causal agents of hybrid sterility and the genes which produce the visible differences between species. This association in Nature is a result of parallel evolution.

Based upon these five assumptions, a working hypothesis is formulated to explain the relationship between evolution between morphological divergence, or cent with modification, and the development of continuities in the variation pattern of natural groups of organisms, or the origin of species. Descent with modification takes place as a result of the interaction between mutation, natural selection, and the fixation of genes in small populations. If these forces are relatively static, the species will not diverge. Discontinuities are developed when two parts of a more or less rapidly evolving species are separated from each other by any of a number of isolating mechanisms. These mechanisms evolve gradually, and are genetically independent of the changes in outward form which produce visibly different species.

TERMITE-PROOFING OF TIMBER

TERMITES, or 'white ants' in popular terminology, are known to most of the inhabitants of the tropical parts of the world, and also to some warm temperate regions such as parts of the United States. Although occasionally introduced into Great Britain, they have never made any headway in this temperate island climate. Various remedies or preparations against the termites' attacks have been introduced or are practised locally in tropical countries—some effective, or partially effective, others more or less worthless. One of the greatest troubles and losses from this pest is the depredations committed on furniture, instrument boxes, packing cases, etc., made in Britain (or in temperate Europe generally) and sent to the tropics, in termite-ested areas such have little chance of escaping destruction.

There is an exception—teak is unattacked, and so articles made from teak are immune. The writer had a full-plate expensive camera in India packed in a beautifully built teak wood box. It was left on the next floor in a corner of a room in a well-built house out in the District. Returning three weeks after an inspection of the box showed traces of termites round the bottom edges. The box was unknocked and lid opened. The wood work of the camera, mahogany, was entirely eaten, skeleton 'beams' and brass pieces being left to support the brass mountings of the camera. At a touch the whole structure collapsed. An examination showed that the bottom of this expensive teak brass-cornered box had consisted of a piece of pine wood.

Leaflet No. 38 (Forest Prod. Res. Lab., Princesborough, Department of Scientific and Industrial Research, Aug. 1944) is entitled "Termite-Proofing Timber for Use in the Tropics". This leaflet opens with the statement that manufacturers in Great Britain handling timber, or making furniture, etc., for use in the tropics are often called upon to render wood proof against possible infestation by the termites, and therefore are directly concerned in the injury which these insects may cause. It is admitted that

in some countries termites cause the most serious damage, especially to permanent structures, unless precautions have been taken during their planning and construction. "In temporary structures and contents of buildings the risk of severe damage, it is said, is less and it need not be assumed that all materials or articles in which wood is present will at once be attacked and rapidly destroyed by termites when brought into a country in which these insects occur." There may be an element of truth in this, but the experience of many must render them chary of subscribing to this statement, or of taking the risk. Temporary structures may be ruined in a few days if left uninspected.

The leaflet summarizes information from a number of publications from certain countries, particularly from those of the Forest Research Institute, Dehra Dun, and the Bureau of Entomology, United States Department of Agriculture, and gives a brief account of how termite damage takes place, and also how it may be prevented. The subject is treated under the headings: habits of termites, prevention of damage, use of timber treated with wood preservatives, use of termite-resistant woods (among those usually available in Great Britain are iroko (*Chlorophora excelsa*), opepe (*Sarcocephalus diderrichii*), Pacific Coast redwood (*Sequoia sempervirens*), teak (*Tectona grandis*)). Plywood and fibre or composition boards and termite attack are also dealt with. It is said that treatment against termites will in most cases also prevent destruction of timber through fungal decay.

MAGNESIUM DEFICIENCY OF FRUIT TREES

THE occurrence of magnesium deficiency of fruit trees growing in the field has been recognized only in recent years. L. Southwick (*Proc. Amer. Soc. Hort. Sci.*, 42, 85, 1943) describes a leaf blotch of apples which appears as an edge burn or interveinal necrosis, together with in some varieties a yellow banding or mottling of the leaves, appearing first in the older leaves and associated with a low magnesium content of the leaves, the scorched leaves usually containing less than 0.25 per cent magnesium. In the same journal D. Boynton, J. C. Cain, and O. C. Compton report that seasonal variations in the potash and magnesium content of apple leaves agree with the seasonal differences in the incidence of leaf scorch and leaf blotch respectively. Leaf blotch due to magnesium deficiency may be reduced by soil application of magnesium sulphate, while it is aggravated by chloride of potash dressings (*ibid.*, 42, 95, 1943). L. Southwick and J. K. Shaw find that spraying with magnesium sulphate solution (16 lb per 100 gallon) gave a partial control of the magnesium deficiency leaf blotch, and that most magnesium-containing substances applied to the soil were effective but magnesium limestone was ineffective in curing the trouble.

In the tung (*Aleurites fordii*) magnesium deficiency symptoms again consist of leaf blotches which increase in size at the margin and the development of brown necrotic areas which progress from the margin inwards between the main veins. As with apples, magnesium sulphate as a soil dressing effects a cure, but soil applications of potash aggravate the symptoms (M. Drosdoff and A. L. Kenworthy, *ibid.*, 44, 1, 1944).

FORTHCOMING EVENTS

Saturday, February 3

BIOCHEMICAL SOCIETY (at the British Post-Graduate Medical School, Ducane Road, Shepherds Bush, London, W 12), at 11 a.m.

Monday, February 5

SOCIETY OF CHEMICAL INDUSTRY (joint meeting of the FOOD GROUP with the LONDON SECTION) (at the Chemical Society, Burlington House, Piccadilly, London, W 1), at 2.30 p.m.—Dr F. Bergel "The Use of Sugars and Amino Acids for the Preparation of Important Nutrients"

ROYAL GEOGRAPHICAL SOCIETY (at Kensington Gore, London, S W 7), at 5 p.m.—Geographical Films

SOCIETY OF ENGINEERS (at the Geological Society, Burlington House, Piccadilly, London, W 1), at 5 p.m.—Mr Frank Parfett Presidential Address

Tuesday, February 6

ROYAL INSTITUTION (at 21 Albemarle Street, London, W 1), at 5.15 p.m.—Prof T. Wallace "The Diagnosis of Mineral Deficiencies in Crop Plants", (2) "Methods of Diagnosis of Mineral Deficiencies"

INSTITUTION OF CIVIL ENGINEERS (STRUCTURAL AND BUILDING ENGINEERING DIVISION) (at Great George Street, Westminster, London, S W 1), at 5.30 p.m.—Mr J. L. Eve and Mr R. C. Brown "The Erection of Tall Guyed Masts"

SOCIETY OF CHEMICAL INDUSTRY (joint meeting of the PLASTICS GROUP with the OIL AND COLOUR CHEMISTS' ASSOCIATION) (at Manson House, 26 Portland Place, London, W 1), at 6 p.m.—Mr J. D. Morgan "The Use of Cashew Nut Shell Liquid in Resins"

Wednesday, February 7

SOCIETY OF PUBLIC ANALYSTS AND OTHER ANALYTICAL CHEMISTS (at the Chemical Society, Burlington House, Piccadilly, London, W 1), at 3 p.m.—Inaugural Meeting of the Physical Methods Group, at 3.45 p.m.—Mr R. C. Christside "Physics and the Analyst", at 4.30 p.m.—Mr H. P. Booksby "Some Examples of the Use of the X-Ray Powder Diffraction Method in Quantitative Analysis, The Determination of Small Amounts of (a) Calcium Oxide in Magnesium Oxide, (b) Zinc Oxide in Zinc Sulphide"

PHYSICAL SOCIETY (COLOUR GROUP) (at the School of Photo-Engraving and Lithography, 6 Bolt Court, Fleet Street, London, E C 4), at 3.30 p.m.—Mr H. M. Cartwright "Colour Printing and Problems of Colour Reproduction"

INSTITUTION OF ELECTRICAL ENGINEERS (RADIO SECTION) (at Savoy Place, Victoria Embankment, London, W C 2), at 5.30 p.m.—Flight-Lieut C. B. Bovill "Aerials for Use on Aircraft—A Comparison between Fixed and Trailing Types on the 900-Metre Wave-Band"

Thursday, February 8

LINNEAN SOCIETY (joint meeting with the ZOOLOGICAL SOCIETY) (at Burlington House, Piccadilly, London, W 1), at 2.15 p.m.—At 2.25 p.m.—Dr F. W. Jane "A Revision of the Genus *Harposiphonia*", at 3.5 p.m.—Prof C. T. Ingold "The Tetra-radiate Spores of certain Aquatic Hyphomycetes and the Propagules in some Species of *Sphaerocarpus*", at 3.35 p.m.—Mr Ashley G. Lowndes "The Swimming of *Monas* (Protozoa)"

ROYAL INSTITUTION (at 21 Albemarle Street, London, W 1), at 5.15 p.m.—Prof James Gray, F.R.S. "Locomotor Mechanisms in Vertebrate Animals", (2) "Animal Flight"

CHEMICAL SOCIETY (joint meeting with the University College of North Wales Chemical Society) (in the Department of Chemistry, University College of North Wales, Bangor), at 5.30 p.m.—Prof M. Polanyi, F.R.S. "The Strength of Carbon Bonds"

INSTITUTION OF ELECTRICAL ENGINEERS (INSTALLATIONS SECTION) (at Savoy Place, Victoria Embankment, London, W C 2), at 5.30 p.m.—Mr D. Rudd "The Development of Motor Control Gear"

IRON AND STEEL INSTITUTE (joint meeting with the EBBW VALE METALLURGICAL SOCIETY) (in the Workman's Hall, Ebbw Vale), at 6.30 p.m.—Mr G. D. Elliot "Blast-Furnace Design, Operation and Problems"

PHARMACEUTICAL SOCIETY (at 17 Bloomsbury Square, London, W C 1), at 7 p.m.—Dr S. A. Sarkisov (representative in Great Britain of the Red Cross and Red Crescent of the U.S.S.R.) "The Health Services of the Soviet Union"

Friday, February 9

ROYAL INSTITUTION (at 21 Albemarle Street, London, W 1), at 5 p.m.—Mr Walter H. Godfrey "Architecture, a Study for Everyman"

NORTH-EAST COAST INSTITUTION OF ENGINEERS AND SHIPBUILDERS (in the Lecture Theatre of the Mining Institute, Newcastle-upon-Tyne), at 6 p.m.—Mr C. C. Pounder "Diesel Propelling Engines—a Comparison of some Alternative Arrangements"

APPOINTMENTS VACANT

APPLICATIONS are invited for the following appointments on or before the dates mentioned

GAS ENGINEER AND MANAGER of the Ilkerton Gas Undertaking—The Town Clerk, Town Hall, Ilkerton, Derbyshire (endorsed "Gas Engineer and Manager") (February 8)

LECTURER IN AGRICULTURE at the Llysfafr Farm Institute—The Director of Education, Education Offices, Ruthin Denbighshire (February 10)

TEACHER OF METAL WORK AND MACHINE DRAWING in the Junior Technical School of the Doncaster Technical College—The Chief Education Officer, Education Offices, Doncaster (February 10)

LECTURER FOR AERONAUTICAL OR MECHANICAL ENGINEER SUBJECTS—The Secretary, Northampton Polytechnic, St John St, London, E C 1 (February 12)

RIVER ENGINEER AND MANAGER (temporary) to the City of York: The Town Clerk, Guildhall, York (February 12)

LECTURER (full-time) IN CHEMISTRY—The Clerk to the Governor South-East Essex Technical College and School of Art, Dagen (February 12)

JUNIOR ASSISTANT DRAINAGE AND IRRIGATION ENGINEER by Sierra Leone Government—The Ministry of Labour and National Service, Appointments Department, Central (T and S) Reg. Room 5/1, Sardina Street, Kingsway, London, W C 2 (quoting Reference No. E 903 A) (February 13)

MASTER to teach MATHEMATICS AND ENGINEERING DRAWING Junior students—The Organizer of Further Education in Rugby Rugby College of Technology and Arts, Rugby (February 16)

LECTURER IN THE CERAMICS DEPARTMENT—The Principal, North Staffordshire Technical College, Stoke-on-Trent (February 17)

ASSISTANT LECTURER (temporary) IN THE DEPARTMENT OF ZOOLOGY—The Registrar, University College, Hull (March 1)

PHYSICIST OR PHYSICAL CHEMIST (man or woman) for research work on the rheology of dairy products, especially cheese—Secretary, National Institute for Research in Dairying, Shinfield, Reading, Berks (April 1)

UNIVERSITY LIBRARIAN—The President, University of Alberta, Edmonton, Alberta, Canada (April 1)

PROFESSOR OF MEDICINE—The Registrar, The University, Manchester 13 (April 24)

UNIVERSITY READERSHIP IN ENTOMOLOGY, tenable at the London School of Hygiene and Tropical Medicine—The Academic Registrar, University of London, c/o Richmond College, Richmond, Surrey (July 31)

SPEECH THERAPIST—The Education Officer, County Hall, Wiltfield

SENIOR LECTURER (male or female) in SOCIOLOGY in the Rhin University College, Grahamstown, South Africa—The Ministry of Labour and National Service, Appointments Department, 3 Sardina Street, Kingsway, London, W C 2 (quoting Reference O S 465)

ASSISTANT DAIRY BACTERIOLOGIST—The Principal, Harper Ad Agricultural College, Newport, Shropshire

TECHNICAL ASSISTANT, and a RESEARCH ASSISTANT, for biochemistry—The Administrator, Oxford Nutrition Survey, 10 Parks Road, Oxford

LABORATORY APPRENTICE (girl) IN THE DEPARTMENT OF PHYSIOLOGY—The Secretary, Bedford College for Women, Regent's Park, London W 1

LABORATORY ASSISTANT FOR PHYSICS DEPARTMENT—Prof Dingle, Imperial College of Science, South Kensington, London S W 7

MANAGER OF THE RESEARCH FARM, Balerno, Midlothian—Secretary Institute of Animal Genetics, University of Edinburgh West Mains Road, Edinburgh

REPORTS and other PUBLICATION

(not included in the monthly Books Supplement)

Great Britain and Ireland

Proceedings of the Aristotelian Society New Series, Vol. Containing the Papers read before the Society during the Sixty-fourth Session 1943-1944 Pp xxx+160 (London Harrison and Sons Ltd, 1944) 25s net

Medical Research Council Industrial Health Research Board Health Research in Industry (Proceedings of a Conference on Industrial Health Research held at the London School of Hygiene and Tropical Medicine, 28th September 1944) Pp 27 (London H. K. Lewis, 1945) 6d net

Freshwater Biological Association of the British Empire Scientific Publication No. 9 The British Simuliidae, with Keys to the Species in the Adult, Pupal and Larval Stages By Dr John Smart Pp (Ambleside Freshwater Biological Association, 1944) 2s 6d

Institution of Civil Engineers Report on the Government White Paper on a National Water Policy Pp 16 (London Institution of Civil Engineers, 1944)

British Coal Utilisation Research Association Programme of Work of Shell-type Boiler and Firing Equipment Committee (R. 18) Pp (London British Coal Utilisation Research Association, 1945)

Other Countries

Proceedings of the California Academy of Sciences, Fourth Series Vol. 25, No. 10 A Revision of some Arizona Cactaceae By P. Lyman Benson Pp 245-268 (plate 25) Vol. 25, No. 11 Endemism in *Crepis* By Prof Ernest B. Babcock Pp 269-290 Vol. 25, No. 12 *Nicotiana glauca*—A New, Naturally occurring, Amphidiploid Species By T. H. Goodspeed Pp 291-306 (plates 26-27) Vol. 25, No. 13 The Cytogenetics of Hybrids in *Bromus* II. *Bromus carinatus* and *Bromus arizonensis* By G. L. Stebbins, Jr., H. A. Togby, Jack R. Harlan Pp 307-322 Vol. 25, No. 14 The Importance of Field Hybrids in Determining the Species in the Genus *Ceanothus* By Prof Howard E. McMinn Pp 323-356 (plates 28-36) (San Francisco California Academy of Sciences, 1944)

Agricultural Experiment Station of the Rhode Island State College Bulletin 291 Food Habits in Rhode Island By Blanche M. Kusch Pp 25 Bulletin 292 Newport City Milk Market By J. L. Tennant Pp 35 Contribution 659 Wartime Agricultural Research (Fifteenth Annual Report) Pp 46 (Kingston, R.I. Rhode Island State College, 1944)

Catalogue

"Loud Hailer" Second edition Pp 24. (Guildford Arde Acoustic Laboratories, Ltd)

NATURE

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LOCAL MUSEUMS AND EDUCATION

SUGGESTIONS FOR FUTURE POLICY

IT is not yet generally recognized that local museums can, or should be able to, make a substantial contribution towards the education of the adult and juvenile population of their respective areas. Even the Ministry of Education, in its various 'recommendations', appears to have overlooked these veritable treasure houses of visual aids. What are the reasons for this? 'Mr. S. F. Markham's Report, "The Museums and Art Galleries of the British Isles" (1938), probably supplies the answer, namely, that the majority of local museums, for some reason or another, are failing to carry out their functions adequately (see *Nature*, 143, 447; 1939).

The Report clearly shows that the main causes for such a condition are (1) the absence of sufficient expenditure, (2) the constitution of the governing body, and (3) "the great number of untrained and part-time curators". All these are closely related. Indeed, condition (2) is directly responsible for conditions (1) and (3), for where the governing body is composed of only half-interested, or frankly uninterested individuals (and this is not a rarity), there is not likely to be much expenditure either on museum improvements or on trained curatorial service. In the present pressing need of education in all its forms, this is an expensive economy.

Again, there are still too many local museums under the 'administration' of a library authority—an unsuitable situation in view of the unrelated work of library and museum. The 'library and museum' committee is not infrequently composed of individuals unacquainted with the work and aims of museums. The result is that the affairs of the museum tend to become subservient to those of the library. In this connexion it is not sufficiently realized that the qualifications of a museum committee member require more than a mere interest in 'old things'.

Such, then, are some of the conditions prevailing in many of the local museums of Britain. These form obstructions to improvement and progress, and, as such, it is high time they were removed. The removal of 'obstructions', however, often requires the impetus of public opinion, and in Great Britain, unfortunately, there is very little public opinion in relation to the local museums.

The United States demonstrates to the whole world the very real value of the museum. In that country, museums were "deliberately created as part of the educational system" ("Libraries and Museums", by Sir Frederic Kenyon, 1930, Benn's Sixpenny Library, No 100). Consequently, American museums have won and maintained strong public interest, and they are, therefore, liberally supported. In view of the attainment in the United States, it seems absurd that the museum-movement (as a whole) in Britain—where so much fine educational material is preserved—should remain 'sleeping' beneath the

impediments mentioned. There are museums scattered all over the British Isles—good, bad, and indifferent—but a great many of the local institutions, at the present time, have to be written off as 'bad' or 'indifferent'. Unless these are reorganized, they can serve no useful purpose in the post-war world. It becomes increasingly apparent, however, that some sort of Government intervention will be necessary before reorganization on the required scale will take place—a poor reflexion, perhaps, on local initiative.

Before passing on to other considerations, it may be appropriate here to mention two museums under the direction of the Education Department of the London County Council which prove their very real educational value. These are the Horniman Museum at Forest Hill, and the Geffrye Museum in Kingsland Road, E 2. The work of both these are well worth the attention of other educational authorities and every public-spirited person.

Those with but a hazy notion of museum values might here ask. What can (or should) a local museum offer towards the education of the people of its area? At least the following: visual instruction; facilities for study, popular lectures, æsthetic recreation, and a service especially designed for schools in the district. The latter should include the distribution of museum loans and arrangements for school talks. The permanent exhibits should be reinforced by a frequently changing series dealing with various subjects, and from time to time there should be special exhibitions to illustrate local talents (art, etc.) and local industries. Only when these amenities are widely offered will public interest be fostered and the local museum serve a useful purpose.

Since a service for schools is an important side-line—and one that promises to increase in scope—we would direct attention to some of the school loans schemes already in operation in Britain. The success of these, even where they are still limited, shows that the museums are strongly placed with regard to the visual aids of which nowadays we read and hear so much.

In this work the Victoria and Albert Museum in London has set the example. In 1937 (see Markham's Report) this Museum had a collection of loans comprising 41,015 works of art, 15,427 lantern slides, and 300 books, and these were issued to 413 secondary schools, 224 art schools, 94 local museums and 96 other institutions. This lead has been followed (naturally on a smaller scale) by the Leicester City Museum (the modern pioneer of such work), and the Derbyshire Education Committee. Both are extensive and county-wide in application, and their 'aids to education' afford a wide selection of portable exhibits dealing with most school subjects. In addition, school talks are arranged, and lately, Leicester has also organized a children's club within the Museum.

The Warwick Museum (Warwickshire Education Committee) launched a scheme—based on those of Derby and Leicester—in 1940. There, it is still in its

early stages, and war-time conditions have made the building-up of the collection difficult. Nevertheless this year several hundreds of items, including cases of museum specimens, models, sets of lantern slides and other illustrative material have been distributed on loan to many schools in the county.

There is an important condition in museum work in relation to schools, and that is the necessity of teachers having enough opportunity of making direct contact with the local museum curator, or schools loans organizer. The teacher should be in the best position to know what, out of the museum's reserves can be of most use for his or her purpose. Again any available museum service should be widely advertised in the schools. Experience has indicated that far too few teachers are acquainted with the services which many museums can, or should render.

It is clear that a considerable amount of educational work lies within the scope of the average local museum, if that institution be given a fair chance. All over the world to-day, the wholesale destruction of cultural material goes on. Some of our own treasures have suffered. Is it not time, therefore that the mass of material still remaining to us be put to its fullest possible use? If, in the words of Sir Frederic Kenyon, "... museums have an important part to play in the formation of the citizen ...", it is vital that we do so.

PHYSICAL ADSORPTION

The Adsorption of Gases and Vapours

By Stephen Brunauer. Vol. 1. Physical Adsorption. Pp. vii+511. (London: Oxford University Press, 1944.) 35s. net.

DR BRUNAUER has given in this, the first part of a work designed to cover all the phenomena of adsorption of gases on solids, by far the most thorough and comprehensive account that has yet appeared. It deals mainly with what is often called 'physical' adsorption, that is, adsorption in which the bulk of the adsorbate is held to the surface by van der Waals' forces, and the gas is below its critical temperature, but sufficient reference is made to 'chemisorption', where co-valent forces come into play, to put the whole subject of adsorption into proper perspective.

The relations between pressure, temperature, and the quantity adsorbed are treated with very great thoroughness, so is the heat of adsorption, and all the various theories which have been advanced to explain the shape of the isotherms. The account of the nature of the binding forces is also very full indeed, the general account of the theories of the nature of van der Waals' attractive forces is as good as that in any text-book. Experimental methods are adequately treated, in all essentials, though rather less completely than is done for theories. The structure of the adsorbent, and also of the adsorbate film, receive as full attention as is possible in the present state of knowledge.

Perhaps the most important section of the book is that which expounds, in full detail, the 'multimolecular

er's adsorption theory of the author, Emmett and
er. This theory takes account of the fraction of
face covered and the heat of adsorption, in each
large number of layers on the surface, in the
layers beyond the first, the heat of adsorption is
in, as a first approximation, as equal to the heat
condensation to bulk liquid. Most of the numeri-
forms which the adsorption isotherms can take
explained, quantitatively, by this theory, with
wance for capillary condensation in the pores. It
takes a very great advance on any preceding theories,
covers the great bulk of all possible cases of
adsorption.

In the discussion of the structure of porous adsorb-
ents, some of the theories quoted, notably those
concerning with the apparent density of adsorbents such
as charcoal, and the hysteresis sometimes found in
adsorption, might perhaps be considerably clarified.
More attention was paid to the contact angle
between the substances adsorbed, when liquid, and
the solid adsorbent. It would seem much more
likely that the contact angle governs the extent of
penetration of liquid into minute pores than the
viscosity, indeed, I think that possibly this angle
is a dominating factor in the values found for the
apparent density, measured by the displacement of
liquids. Perhaps also the well-known hysteresis of
contact angle, coming into play as an 'advancing'
angle when capillary spaces are being filled with
liquid, and a 'receding' angle, always smaller
than the advancing angle, during desorption and
emptying of capillaries, is largely responsible for
adsorption hysteresis. The rather far-fetched theory
which claims that pores in some adsorbents resemble
'bottles' in shape might prove superfluous if
attention were paid to this hysteresis of contact
angles.

In the treatment of the state of the adsorbed film in
equilibrium, the author does not commit himself for, or
against, recent theories which regard the adsorbed
layer as possessing most of the properties of a two-
dimensional gas even to the extent that the outward
face pressure of these gases can cause expansion
of the adsorbent. Neither are the discontinuities in
adsorption isotherms, now based on experimental
evidence from a number of sources, treated, except
as a curious phenomenon not at present to be inter-
related with the rest of the theory. This caution
might, however, seem well justified in the present
state of knowledge.

The author is to be congratulated on a very fine
treatment of a complex subject, more complex perhaps
than most non-specialists will have suspected. He
has given a very learned and well-balanced picture
of practically all the important theories that have
been proposed, and there are many of them. It is
partial—perhaps for some tastes a trifle too
partial, for the book has, in places, to be very
carefully read to ascertain what the author's own
views are, but the reader is always given very full
material on which to base his own judgment.

The preface warns that we shall have to wait some
time for the second volume, which is to deal with
chemical adsorption. This is tantalizing, for one
cannot give such a stimulating account of what
any people would expect to be the less interesting
half of the subject should have something enthralling
to say about the other half. He does, however, let
me make one provocative remark, to whet our appetite for
what is still to come, saying on p. 10, "there is some
position even to-day to accepting the concept of

activated adsorption." I myself, being still some-
what sceptical that slow adsorption can legitimately
be ascribed to an energy of activation in the chemi-
sorption of gases in the first layer, look forward
impatiently to the author's promised marshalling
of the evidence in its favour. It is a very important
point of theory, and no one can be better fitted than
the author for bringing all the evidence into proper
focus, his knowledge is unsurpassed, and his fairness
as an expositor seldom equalled. N. K. ADAM

AVIATION MEDICINE

A Bibliography of Aviation Medicine and Supple- ment

By Phoebe Margaret Hoff, Ebbe Curtis Hoff and John
Farquhar Fulton (Publication No. 9, Historical
Library, Yale Medical Library) Pp. xiv+109.
(Washington, D.C. National Research Council,
1944) n.p.

AVIATION medicine has become a subject of
prime practical importance in the present War.
It is a subject in which the basic data from many
fields of physiology are required in new applications.
The compilation of a bibliography of aviation medi-
cine is therefore a work of great value to those inter-
ested in this field. A large volume of work done in
Service laboratories is not included, as this has not
yet been published in open form, this is often less
due to secrecy provisions than to the extreme pre-
occupation of the research workers with urgent
operational problems. For, while many of the applica-
tions of physiology to aviation carried out in Service
laboratories are at present restricted by secrecy con-
siderations, the scientific basis of most of these rests
on fundamental physiology often published many
years before the War, this bibliography covers the
field in all its ramifications. Only a few applied
sections are seriously incomplete and must remain
so until after the War.

This Bibliography, first published in 1942, is now
followed by a supplement, mostly of work published
since 1940.

The classification by subject-matter is convenient,
and all references are given numbers used for refer-
ence in cross-indexing at the foot of each subsection.
An author index is included.

The section "Special Physiology of Aviation and
Conditions Simulating Flight" occupies nearly half
the volume and is divided into twenty-three physio-
logical divisions further subdivided.

The Bibliography is comprehensive and includes
historical works and accounts of early balloon and
mountain ascents where these contained any pertinent
matter.

Research on the effects of altitude may be divided
historically into two parts, from Robert Boyle to
Paul Bert, and Paul Bert to the present. Robert
Boyle subjected animals to low pressure and re-
corded seeing a bubble in the eye of a viper when
exposed to low pressure, and so might be considered
the discoverer of decompression sickness. Modern
research dates from Bert, who laid the main founda-
tions of modern knowledge in his great work "La
Pression Barométrique", published in 1878.

The book is excellently produced, and the arrange-
ment could well serve as a model of bibliography.

B. H. C. MATTHEWS.

PLANT VIRUSES AND VIRUS DISEASES*

By F. C. BAWDEN

Rothamsted Experimental Station

THE existence of viruses was first deduced from work done in 1892 on tobacco plants suffering from mosaic, and much of what we now know of these elusive entities has come from further work on this and a few other plant diseases. It is far from certain that this knowledge can safely be applied to the causes of the many diseases, affecting all kinds of animals, higher plants and bacteria, that are now attributed to viruses. These cover a wide range of clinical conditions, and we know for certain of only two features that they have in common, their causes have neither been seen nor cultivated *in vitro*. If we wish, we can turn these negative features into what looks like a positive statement, by defining viruses as obligately parasitic pathogens too small to be resolved by microscopes using visible light. Indefinite as this is, it may still prove to be more precise than the facts warrant, for obligate parasitism is always postulated rather than proved, and serious attempts at cultivation have actually been made with very few viruses. Thus, when we speak of a virus disease, we usually mean merely an infectious disease with an invisible cause. Unless the resolving power of the microscope has some unsuspected significance in defining biological types, this obviously tells us nothing specific about the nature of viruses and might well cover a range of different entities.

This possibility seems increasingly likely when we try to generalize about plant virus diseases, for we find that no statements can be made about such features as symptoms, methods of infection, or distribution of virus in the host, to which there are no exceptions. This is far from conclusive, however, for what a virus does to a plant is as much a property of the plant as of the virus, and the same virus may produce very different effects in different plants. Also, although complete generalizations are impossible, there are some features shared by a number of different virus diseases, especially those met commonly in Nature.

The effects most frequently caused by viruses are a dwarfing of the host plants and an alteration of the colour and shape of the leaves. Instead of being uniformly dark green, the leaves may bear spots, rings or patches of light green, yellow or white, or they may be generally chlorotic without definite mottling. Deformation may show only as an alteration in the leaf outline, or the laminae may be so reduced that the leaves consist of little but the main veins, it may take the form of local hyperplasia, to give unusual outgrowths from the leaves or gall-like proliferations in stems. Symptoms tend to occur more generally over a whole plant than with most fungal or bacterial diseases, for in natural infections it is usual for viruses to spread through the vegetative parts of affected plants. In plants infected experimentally, however, symptoms are often restricted to local lesions, produced by the death of tissues around the entry point. Diagnosis from symptoms is by no means easy, for different viruses may cause almost identical symptoms in the same host, whereas the same virus may produce totally different clinical

conditions in different hosts. A further complication is that many viruses are unstable and frequent change to give forms that produce different symptoms from those produced by the parent virus. To be recognized, a virus must cause changes in the appearance of some plants, but it need not necessarily cause changes in all susceptible hosts. Indeed, the phenomenon of the carrier—an infected individual showing no symptoms—is common in plants, as such carriers can be of considerable importance as unsuspected sources of infection for intolerant species.

In many virus diseases, three distinct phases can be identified. As a result of virus multiplication sites of infection, lesions first appear on inoculated leaves. After a few days, the virus passes to the phloem, through which it travels rapidly to distant parts of the plant. It seems to have no autonomous movement, but to travel along with the translocation stream of elaborated food materials, away from tissues actively engaged in photosynthesis and towards regions of active growth. It is because of this, and not because they resist infection, that leaves already fully developed at the time the plant becomes infected rarely show symptoms. The results of systemic infection appear on the young actively growing leaves, the later symptoms of the systemic phase often differ from those first produced as the disease passes from an acute to a chronic stage. Often both stages are serious diseases, in many potato varieties, for example, leaf-drop-streak succeeded by severe mosaic. Occasionally, however, the chronic stage is extremely mild, such as tobacco plants with ring-spot, which recover from an acute necrotic disease and afterwards show few or no symptoms. The virus is present in such plants, but in smaller quantities than during the acute stage. The sequence of three phases is common, but by no means general, and the same virus may give different sequences in different hosts. Potato virus Y, for example, gives local lesions only in one host, local lesions followed by systemic symptoms of two kinds in a second host, whereas in a third it gives no local lesions and systemic symptoms of only one kind.

In addition to altering the external appearance of plants, viruses also produce internal changes. Some of these are simply modifications of normal structure or tissues, such as reduction of the chloroplasts, necrosis of the phloem, but the most characteristic involve the production of new kinds of intracellular inclusion bodies. These are not found in all virus diseases, but their formation appears to be specific to viruses, for similar bodies have not been found either in healthy plants or in those suffering from other kinds of disease. Different viruses give rise to different kinds of inclusion body, and produce them in varying numbers and in different tissues. The most general type is a vacuolar, amoeboid-like body found in the cytoplasm, but crystalline or fibrous inclusions also occur in infections with a number of different viruses. At least two viruses give rise to crystalline inclusions in the nucleus. The precise nature of these bodies is still uncertain, but we know that they contain virus, and their production can in part be simulated *in vitro*. It seems most likely that they are insoluble complexes produced by the viruses combining with some metabolic product of the diseased plants.

Symptomatology without proof of transmissibility is insufficient to assign a particular disease to a virus group, for similar kinds of symptoms can be caused by toxins, deficiencies of mineral nutrient

* Substance of two lectures at the Royal Institution on November 21 and 28.

id aberrant genes With hosts that are easily grafted, transmission by grafting is usually the first method tried, for once organic union is established, all viruses that cause systemic symptoms readily pass from infected scions into healthy stocks Indeed, grafting is the only method of transmission known for many virus diseases, and it has almost become the critical test of a plant virus disease

Infection occurs only through wounds, but wounds do not permit one virus to enter may not permit another Many viruses are readily transmitted by rubbing healthy leaves with sap from diseased plants, but others are not, some of both these types are transmitted by insects Several different explanations can be offered for the failure of inoculation to transmit viruses that are readily transmitted by insects First, some viruses may be able to establish themselves only in deep-seated tissues, such as the phloem, which are not penetrated by ordinary inoculation methods Secondly, conditions in the pressed sap of some hosts may be such that the viruses are rapidly destroyed or rendered non-infective Thirdly, the virus content of sap from diseased plants may be below that required for infection Thus, although failure to transmit by inoculation is often used as a specific character of a virus, clearly it may equally well be a reflexion of some property of the host

Insects do not seem to act simply as mechanical carriers of viruses, for no insect vectors are known for the two viruses most easily transmitted by inoculation, and there appear to be specific relationships between insects and the viruses they transmit Individual viruses are usually transmitted by only a few related species of insect and not by others, although these may have similar feeding habits and be vectors of other viruses Vectors are usually insects with sucking mouth-parts, the most important are aphids, leaf-hoppers, white-fly and thrips Two main types of behaviour in the insect have been distinguished Vectors of one type of virus can infect healthy plants immediately after feeding for a short time on a diseased plant, and these usually cease to be infective within a few hours After feeding on diseased plants, vectors of the other type cannot infect healthy plants for some time, which varies from minutes to days with different viruses, and such vectors remain infective for long periods, often for their whole lives Some workers believe that viruses of the second type multiply in the insects There is

an obvious reason why they should not, and the theory would explain some of the now puzzling features of the behaviour of these viruses, but there is no conclusive evidence that insects ever contain more virus than they acquire while feeding on infected plants Studies on the virus causing dwarf disease of rice supplies the best circumstantial evidence for multiplication This virus is unique in being the only one known to pass from infective adults through eggs to their progeny Progeny up to the seventh generation have once been found to be infective and from one infected egg the progeny have infected more than 1,000 plants This is regarded by some workers as 'overwhelming' evidence of multiplication, as they consider that the quantity of virus in the original eggs could not have been enough to give all the infections But is this so? Is the virus multiplied in the insects to anything like the extent it does in plants, then there would be no reason why the progeny should not continue to be infective indefinitely, and infect as many plants as

they feed on We know nothing of the size of this virus, but if it is of the same order as other plant viruses the sizes of which are approximately known, then 1,000 particles would weigh less than 10^{-14} gm., and many times this quantity could surely be contained in a leaf-hopper's egg without difficulty

Transmission of some viruses has been achieved by linking diseased and healthy plants with the parasite dodder (*Cuscuta* sp.) This novel method of transmission promises to be valuable in extending the host ranges of some viruses to plants more favourable for study than those in which the viruses occur naturally One of the greatest differences between individual viruses lies in the numbers of different plants they can attack Some are known to infect hundreds of plant species, belonging to many different families and orders, others have been transmitted to only a few closely related species This difference may be apparent rather than real, for viruses transmissible only by grafting or by insects will normally have host ranges restricted to plants which can be inter-grafted or which can act as food plants for the insect vector

For more than forty years, work on plant viruses was largely concerned with symptoms, transmission and host ranges It showed that viruses could multiply and alter, and produced few results conflicting with the generally accepted conclusion that they were small organisms, essentially similar to bacteria There were opposers of this, usually from among those studying tobacco mosaic virus, but they could offer nothing definite to support their alternative views The intensive study during the last ten years of the viruses *in vitro* has led to results that necessitate considerable modification of the earlier views They do not, however, justify the sweeping conclusions implied by such facile phrases as 'lifeless molecules', which are increasingly applied to viruses

What has been achieved is the successful application of the techniques of protein chemistry to the purification of a dozen or so viruses This has shown us that the particles of these viruses are not organized cellularly like organisms, and that in many ways they resemble constituent parts of organisms rather than whole organisms They can be obtained in forms chemically much simpler than bacteria, free from diffusible components, and with a much greater regularity of internal structure than is usual with organisms The viruses so far purified have all been obtained in the same chemical form, as nucleoproteins They all contain nucleic acid of the ribose type, but the proportion of nucleic acid to protein varies with the individual viruses It is far too early to conclude that all plant viruses are essentially nucleoproteins, but we can say that it will be a major discovery if one is found to be anything else, for those already purified cover a diversity of types, some known to be insect-transmitted and others not They range from potato virus Y, which denatures and loses infectivity within a few days, to tobacco mosaic virus, which remains stable for years Stability as a native protein, however, is not always the same thing as stability as a virus, the infectivity of preparations of any of these viruses can be destroyed by some treatments that have no appreciable effects on the physical, chemical and serological properties

The shape of the particle is responsible for some of the most striking differences between the properties of preparations of different viruses Solutions of purified tobacco mosaic virus, and of potato viruses X and Y, show phenomena characteristic of greatly

elongated particles, they are anomalous in all their physical properties and are polydisperse. No true crystals have been prepared from these, but dilute solutions show anisotropy of flow strongly, and concentrated solutions are liquid crystalline. X-ray studies of solutions of tobacco mosaic virus have demonstrated a regularity of structure previously unsuspected in fluids, for the particles are arranged equidistant from one another so that the available space is filled uniformly. When mixed with their antisera, these rod-shaped virus particles precipitate almost immediately, giving bulky, fluffy precipitates resembling those produced by bacterial flagellar antigens.

Solutions of bushy stunt and tobacco necrosis viruses behave very differently and show none of the anomalous properties characteristic of elongated particles. By suitable treatments they can be induced to crystallize in forms characteristic of the individual virus. When mixed with their antisera, they precipitate more slowly than the rod-shaped viruses and, as might be expected with spherical particles, pack more closely to give dense, granular precipitates resembling those produced by somatic antigens.

What is the relationship between these isolated nucleoproteins, which in laboratory work behave much like preparations of other proteins, and the viruses as they occur in the plant? There is enough evidence now to show that these proteins are the viruses in the sense that they can initiate infection. Nevertheless, it would be premature to assume that, while active in the host plant, the viruses are chemically so simple as analysis of the purified preparations suggests. During the course of isolation, many materials are discarded as impurities, most of these are certainly constituents of the normal host, but some may well be specific products of virus activity. Any such are clearly not essential for infectivity, but if the virus were organized cellularly, they would be retained within a cell wall and would be accepted as integral parts of the virus, which would immediately look a much more complex body than does our naked protein particle.

In the absence of specific tests for any product of virus activity, we have no positive evidence for their occurrence in plants, but evidence from various sources suggests that purification may be altering the viruses. Purified preparations of tobacco mosaic virus, for example, contain particles about 15 μ wide but varying in length from less than 100 μ to more than 1,000 μ . There is nothing to show that the greatly elongated particles occur in the plant, and much to suggest that they are produced by the linear aggregation of small particles during the course of preparation. By taking suitable precautions, solutions of tobacco mosaic virus can be made that show little or no anisotropy of flow and behave serologically more like somatic antigens, but these are unstable and readily change into anisotropic solutions with serological behaviour characteristic of flagellar antigens. This change seems to be connected with the removal of other material from the small nucleoprotein particles, which then join together end-to-end. The change in size and shape may explain the failure to produce true crystals of this virus *in vitro*, though they occur abundantly in infected plants.

We know also that the purified virus readily combines with other proteins such as trypsin and ribonuclease, and that these can be removed again without affecting infectivity. May not similar com-

binations occur within the host, and be responsible for converting this nucleoprotein into a functional system capable of multiplication and of the activities of which the results are so obvious?

In addition to the changes produced by purification, there is other evidence that virus does occur in the plant in forms with different properties from those of the purified nucleoprotein. Until recently, all laboratory work on plant virus was done with the sap that is expressed from macerated infected leaves. This was thought to contain all the virus in the plant, for washing the fibrous residues gives little extra virus. However, these residues actually contain as much virus as does the sap, but normally this is insoluble, probably because it is combined with other substances, and special treatments are needed to get it into solution. It is possible that this insoluble virus is the biologically active system, whereas that free in the sap may be merely excess virus functioning as a mobile source of infection for other cells. We know so little about the multiplication of viruses, and of their activities with the host, that at present we must suspend judgment. But it is probably safest to regard the nucleoprotein as the chemical minima—equivalent to reproductive organs or embryonic viruses—which develop into working entities only when placed in an environment containing the materials or enzyme system they lack in their purified state.

CHEMISTRY AT THE OLDER UNIVERSITIES OF BRITAIN DURING THE EIGHTEENTH CENTURY

By ARCHIBALD CLOW

University of Aberdeen

IN 1814 Sir John Smellie, president of the Board of Agriculture, wrote:

"At present there are a greater number of intelligent practical chemists in Scotland, in proportion to the population, than perhaps in any other count in the world" (J. Smellie, "General Report", App. p. 307).

In the light of this rather startling assertion, it is instructive to analyse the development of chemistry in the universities of Scotland during the preceding hundred years, and to compare it with development farther south. In Great Britain there are five universities to consider—in England, Oxford and Cambridge, in Scotland, Edinburgh, Glasgow and Aberdeen. There was no profession of chemistry in Scotland until at a later date.

While alchemy yet held the field, the universities of Scotland remained aloof from the flux of gold as elixir making, but at the end of the seventeenth century the Surgeons' Incorporation in Edinburgh established a laboratory where apprentice apothecaries received a chemical training. The instigator of this pioneer development was Alexander Monteith. He was thus a contemporary of Sir Isaac Newton (1642–1727), who in Cambridge was still studying Boyle's method of gold-making during 1690–4, perhaps not without hope of practical application, since within a few years he was appointed Ward of the Mint.

In the early years of the eighteenth century, the Town Council of Edinburgh decided to appoint

professor of chemistry in the Town's College, and in 13 James Crawford was selected to fill the chair. Crawford did not achieve European reputation, but was a product of the great Boerhaave school at Leyden, and his appointment to Edinburgh is significant. It inseminated Scotland with the finest seed.

Continental chemistry, and it gave professorial status to a teacher of chemistry in advance of most other countries. The only other university with a claim is Oxford. On cursory examination it appears that, as a centre of chemical activity, Oxford is indeed a better claim. This arises in the main from its association with the alchemist Roger Bacon, but even R. T. Gunther points out that it is a moot point whether Roger Bacon really made much impression on his contemporaries, if any, it was evanescent, and in the succeeding centuries Oxford savants continued to wander in a maze of arbitrary figments and partial inductions, in which experimental science found no place" (R. T. Gunther, "Early Science in Oxford", 7).

In the middle of the seventeenth century, we find at for a time Oxford did indeed give hospitality to an evacuee, Robert Boyle (1627-91), one of the greatest of contemporary thinkers. For fourteen years from 1654 Boyle was at Oxford. While there, he came the centre of a small coterie of intellectuals who doubtless helped to bring about what J. U. Nef calls the first English industrial revolution. Boyle's influence was rather that of a patron experimentalist than a teacher, but he was responsible for introducing to Oxford its first regular teacher of practical chemistry. It was a long time, however, before the teaching of chemistry became continuous. In compensation for the paucity of chemical instruction, an important contribution to technique made by an Oxford B.C.L. may be mentioned.

"The mystery of salt-glazed stone ware was discovered by the ingenious John Dwight of Christ Church, who set up a manufacture at Fulham, London, and where John Dwight became acquainted with this use of salt is not known but in 1671 he took out a patent for his process, and in the same year the first specimens of salt-glazed ware were being manufactured at Fulham. Soon after 1688 similar ware was being produced at Burslem by the technician Elers, and in 1700 in Nottingham" (R. T. Gunther, "Early Science in Oxford", 27).

Oxford suffered from its proximity to London, and the removal of Boyle (as well as of other intellectuals who followed the more settled conditions of state established in 1660) did irreparable damage to its scientific life. The only man of science worthy of the name who remained was John Mayow, whose "De nitro et spiritu nitro-aereo" heralded the later discovery of oxygen. But Mayow too left Oxford in 1655, and died in 1678.

"Thus closed the brief life of the greatest chemist whom Oxford has ever produced. His works, a century in advance of the times, were unappreciated during his life and were soon neglected, buried and forgotten under a thick pall woven in Germany by a school, out of a warp of genuine facts and a weft of false hypotheses" (R. T. Gunther, "Early Science in Oxford", 32).

By one of the unfortunate accidents to which legiate monasticisms are prone, Mayow was not an associate of Boyle, indeed they seem to have been mutually unaware of each other's work, and Mayow's contributions remained hidden for many years. Yet manipulative skill substantiates his claim to be

considered one of the founders of pneumatic chemistry. Thus while Oxford may claim an earlier contribution of chemistry applied to manufactures than can Edinburgh, its periods of seventeenth century brilliance were sporadic and contrast markedly with the continuity of chemical teaching undertaken at Edinburgh.

So far as continuity is concerned, albeit it was mediocre, Cambridge fared better than Oxford. In the early years of the eighteenth century, that is, contemporary with Crawford's professorship at Edinburgh, the title of honorary professor of chemistry at Cambridge was conferred on one J. F. Vagani (c. 1650-1713), a native of Verona. Of Vagani we know little, but he was probably the first chemist there to throw off the alchemical tradition. From records of purchases made to illustrate his lectures, it is highly probable that they were biased towards pharmaceutical ends. It is interesting to note that one of Vagani's students was Stephen Hales (1677-1761), whose researches on the chemical reactions of plants laid the foundation on which Francis Home of Edinburgh was able to build his "Principles of Vegetation".

Vagani was followed by John Waller, who lectured until 1718, and Waller in turn by John Mickleburgh, who brings us up to 1741.

By this time great changes had taken place in Scotland. In 1724, four fellows of the Royal College of Physicians announced that they had purchased a house in Edinburgh for a chemical laboratory, and indicated that they proposed to lecture extra-murally on chemistry and *materia medica*. Every one of them had studied at Leyden under the celebrated Boerhaave, and thus went to Edinburgh with the finest training that could be obtained at the time. They were Drs. John Rutherford (1695-1779), Andrew Plummer (d. 1756), John Innes (d. 1733) and Andrew St. Clair. After extra-mural teaching for a few years, they insinuated themselves into the University, which for a time boasted four "professors of chemistry". None of the quartet made revolutionary contributions to the advance of chemical theory or practice—Rutherford's son discovered nitrogen, it is true—but their significance in the history of technology and science lies not in their own contribution but in the pioneer foundations established by their students. Plummer particularly was the mentor of several founders of chemical industry, as well as of two of the greatest academic chemists of Scotland, or for that matter any country, has produced, namely, William Cullen (1710-90) and Joseph Black (1728-99).

Of Plummer's industrialist pupils, John Roebuck (1718-94) is the most important. The manufacture of sulphuric acid was first carried out in England on what may be called an industrial scale when Dr. John Roebuck, in company with Samuel Garbett (1717-1805), established his works at Steelhouse Lane, Birmingham, in 1746. They set up a second works at Prestonpans in 1749, and with the profits gained in these very successful enterprises Roebuck went on to found Carron Iron Works in 1760, thus opening up for the first time the carboniferous deposits of central Scotland.

The establishment of sulphuric acid manufacture on an industrial scale in both England and Scotland by Roebuck and Garbett—and it must be remembered that Roebuck's interest in chemistry was derived from Plummer's teaching at Edinburgh—is of signal importance, since it almost immediately brought

about a revolution in the art of bleaching by the application of the researches of another Edinburgh professor, Francis Home (1719-1813), professor of *materna medica* in the University from 1768. The introduction of sulphuric acid at this early stage in the industrialization of bleaching was indeed a milestone in the long chain of contributions made by Scottish chemists to industrial development.

About the same time as Roebuck settled at Prestonpans, another student of Plummer began to engage in chemical manufacture. He was no other than the celebrated Scottish geologist, James Hutton (1726-97). Beckmann in his "History of Inventions and Discoveries" states:

"If I am not mistaken, the first real manufactories of sal ammoniac were established in Scotland, and the oldest of these, perhaps, was that erected by Davin and Hutton at Edinburgh in 1756* and which, like many in England, manufactures this salt on a large scale" (4, 383).

Soot was the raw material used, and they continued to use it for many years until they began to buy crude sal ammoniac from a tar works that had been established in the interim by Lord Dundonald at Culross.

All this has to be set against "the mystery of salt-glazed stone ware", contributed by Oxford.

From Edinburgh the teaching of chemistry spread to the University of Glasgow. William Cullen (1710-90), having studied arts at Glasgow and medicine under Plummer at Edinburgh, was appointed a teacher of medicine at Glasgow in 1746. Stimulated by Plummer's teaching, he developed a dominant interest in chemistry, and in 1747 induced the University to establish the teaching of *Chemie*. In the same year, Cullen himself, and a John Carrick, were appointed lecturers in chemistry. Carrick, however, died in 1750, and Cullen was left to continue the course on his own.

Cullen's outlook on chemistry was severely practical, as has been that of all great Scottish chemists. At the beginning of his second course he printed and distributed "The Plan of a Course of Chemical Lectures and Experiments directed chiefly to the Improvement of Arts and Manufactures". He clearly recognized the importance of scientific chemistry and its application to industrial and agricultural development. While in Glasgow he devoted a considerable part of his time to industrial problems of the time, particularly to those subjects of which industry demanded a chemical investigation, for example, salt-boiling, bleaching, and alkali supply.

"He was a great master of the scientific branches of husbandry, a consummate botanist, and possessed a correct taste in the fine arts. In the year 1758, after finishing off chemistry, he delivered to a number of particular friends, and favourite pupils, more lectures on the subject of agriculture. In these few lectures, he, for the first time, laid open the true principle concerning the nature of soils, and the operations of manures" (A. Bower, "History of the University of Edinburgh", 2, 392).

In 1751, Cullen was appointed professor of medicine and lecturer in chemistry at Glasgow, which posts he held until 1755, when he was appointed colleague and successor to Plummer, and moved to Edinburgh. In Glasgow he was succeeded by Joseph Black (1728-99), who followed him both at Glasgow (1756) and later at Edinburgh (1766).

If we compare the number of students reading chemistry at Edinburgh and at Cambridge at the period, it is likely that Edinburgh will be found to have the smaller number, but an expansion to place almost immediately. In the light of the figures we can sympathize with Davies, who wrote to Stephen Hales in 1759 lamenting that at Cambridge,

"Anatomy, botany, chemistry, and pharmacy have been but occasionally taught, when some person of superior talents has stayed up and has honoured the University by his first display of them, before his passage into the world" (R. Davies to S. Hales, 1759).

In Scotland at this date Cullen was teaching Edinburgh and Black in Glasgow.

In 1766 Black went to Edinburgh to succeed Cullen who had been translated to another chair, and for thirty years he occupied the chair of chemistry during one of the great formative periods through which chemistry has gone, both in expansion on the theoretical side and in its application to industry. So great were Black's contributions to fundamental chemistry that one is apt to forget that he also kept close touch with contemporary industrial developments, especially in a consultative capacity, and through personal contact with friends like Roebuck and Hutton. Of particular interest are his attempts in collaboration with Roebuck and James Watt, to synthesize alkali, his connexion with the initial stage of Lord Dundonald's Tar Works. Problems concerning Cort's process for the production of malleable iron were referred to him. He advised on potteries. Specimens of ore and water from the lead mines at Wanlockhead and Leadhills were sent to him for analysis. His opinion was sought by the committee investigating Scottish distillation. He devised methods for the chemical assay of kelp.

What of chemistry in the 'older' universities? Mickleburgh, who had been appointed to Cambridge shortly before Cullen, went to Glasgow, gave way to John Hadley (1731-64), and he in turn to Richard Watson (1737-1816), afterwards Bishop of Llandaff, who was appointed professor of chemistry at Cambridge in 1764. At the time of his appointment was said of Watson that "he knew nothing at all of chemistry, had never read a syllable on the subject, nor seen a single experiment in it". In two years illustrious Black was to succeed Cullen at Edinburgh. Small wonder that the evolution of chemical science in the two countries was so different. Yet Watson was no idle churchman. He took his new appointment very seriously, and has related how at one period conscience forced him to burn his chemical writings lest he be lost to the church altogether. Among other activities, he took steps to make the occupation of the chemical chair more secure by persuading the Crown to make an annual grant of £100. It should be noted that initially there was no stipend attached to the chair that Cullen and Black occupied. They were remunerated by their students' fees and takings of private medical practice.

Despite his inauspicious start, Watson was the first Cambridge chemist to evince any interest in advance of industry based on exact chemistry knowledge which was taking place in various parts of the country. His "Essays", published in 1784-88, contain useful pictures of various industries, particularly on coal, lead and zinc, and his researches on charcoal production for gunpowder by closed distillation.

* The correct date is a good deal earlier than that given by Beckmann.

od are known to have saved the Government large sums of money

Black's influence was transmitted throughout the civilized world by the appointment of his students to influential positions in the academic and industrial world. Black was to Edinburgh what Boerhaave was

Leyden. Not only did his students, Robison, Irvine, Hope, Cleghorn, and Thomson, follow him in the lectureship at Glasgow and chair at Edinburgh, but also others founded chemical schools throughout the country and abroad. Ogilvie went to Aberdeen, Thomas Garnett to the Andersonian University of Glasgow, J. Morgan and B. Rush established the teaching of chemistry at Philadelphia. Wm. Henry, the Manchester chemist, studied under him, as did R. Humphry Davy's brother John. Humphry regretted that it had not been his own good fortune to study under Black. But of particular importance is that two of his students had a vitalizing effect on the lethargic schools at Cambridge and Oxford. Let us follow the evolution of Oxford after the death of Mayow referred to above.

Oxford chemistry did not recover easily from the loss of Mayow, although one might have expected the Ashmolean foundation to bring about a revival. A number of chemists followed in the laboratory established by Elias Ashmole (Robert Plot, Edward Smeaton, John Freind, Richard Frewin), but none of them succeeded in establishing any sustained teaching research school.

"The reason for this sterility was not far to seek. The Oxford contemporaries of Newton had not the inquiring mind, the most brilliant of her sons devoted their genius to other ends and developed their talents in other places, those who stayed behind were content to accept the statements of others without testing them for themselves, and to pass on to their students information acquired at second-hand. The business of teaching was set higher than the duty of research." (R. T. Gunther, *Early Science in Oxford*, 53.)

Ashmole's inadequate foundation was, from the chemical point of view, a failure, and chemistry continued to lag behind other expanding sciences. No university professor was appointed, with the result that students who wanted to acquire some familiarity with the science had no one better to instruct them than the college fireman.

The only interesting outcome of the Ashmolean period is the association of John Wall (1708-76) of Exeter with the foundation of the Worcester Porcelain Company (1751), but such a connexion cannot

be considered adequate to compensate for the new level to which Oxford intellectual life sank in the earlier part of the eighteenth century. Wall's connexion with Oxford was strengthened through his son, Martin Wall (1747-1824), delivering a course of lectures there from 1781 in the capacity of 'public reader in chemistry'.

The next development in the chemical history of Oxford was of great importance (corresponding as it did with the appointment of Smithson Tennant to Cambridge) it was the appointment of Thomas Beddoes (1760-1808), also a student of Joseph Black at Edinburgh, to be reader in chemistry. Beddoes was only at Oxford from 1788 until 1793, but for a time at least chemical interests there were revived by his enthusiasm, and it is on record that at such was the revitalized interest he created that attendance at his lectures exceeded anything known at the University since the thirteenth century. Here

in Oxford was the vivid effect of Black's infectious personality re-enacted. Beddoes' short readership in chemistry was but a phase in his life, and the Pneumatic Institute at Bristol which he founded spread Black's influence in another direction. It cannot be said that Beddoes' short sojourn at Oxford led to any great chemical efflorescence, but in 1803 a professorship of chemistry was endowed, and with it the establishment of regular teaching, something that had been in progress in Edinburgh for almost a century.

Cambridge was rather more fortunate than Oxford with its chemists. Richard Watson was followed by Isaac Pennington, and he in 1793 by W. Farish, who like Cullen in Glasgow lectured on the "Application of Chemistry to the Arts and Manufactures of Britain". In Farish's lectures we see a swing-over to an appreciation of the important contribution that chemistry was making to the industrial revolution. They covered smelting metallic ores, the uses of coal, such industrial chemicals as sulphur, alum, salt, acids, and alkalis, the chemical arts of bleaching and preparing cloth, and the production of mordants, etc. This highly practical approach heralded the further break with tradition, namely, the appointment of a chemist trained in the Scottish schools to the Cambridge chair. In 1813 Smithson Tennant (1761-1815), who had been in Cambridge since 1782, was appointed to the vacant chair of chemistry.

By this time Scottish chemistry, nurtured in the faculties of medicine at Edinburgh and Glasgow, had achieved a European reputation, and so the successors of Cullen and Black had an assured flow of talented students out of all proportion to that which came to Tennant and Beddoes, despite the latter's popularity as a lecturer.

When Black went to Edinburgh from Glasgow, he was succeeded by J. Robinson (1739-1805), and he in turn by William Irvine (1743-87), both students of his own. Irvine died in 1787, and was succeeded by Thomas Charles Hope (1766-1844). Hope only occupied the chemistry lectureship for four years before transferring to the chair of medicine, but his interest in research and his ability as a teacher maintained the reputation of the Glasgow school built up by Cullen and Black, whom he ultimately followed at Edinburgh as well (1799). Hope added still another of the elements (strontium) to be discovered by Scotsmen. On his translation to medicine he was succeeded by Dr. Robert Cleghorn (1777-1821), who continued to lecture on chemistry until an independent chair was founded in 1818.

~ This was an era of great industrial development by the application of chemistry to the arts in Scotland, during which the link-up between industrialists and universities was further strengthened. One need only mention in passing the introduction of chlorine bleaching at Gordon Barron and Company's Woodside Works through the activities of Prof. Patrick Copland (1749-1822), professor of natural philosophy in Marischal College, Aberdeen, the production of the dyestuff *cudbear* and the development of turkey red dyeing by George and Charles Macintosh, the latter a student of Black, the patenting of bleach liquor and bleaching powder in the name of Charles Tennant of St. Rollox, and the general contribution made by the Tennant-Macintosh nexus in the way of heavy chemicals and ancillaries to the dyeing and finishing trades. Under Hope's influence the development of chemistry was rapid and of increasing economic importance. On account of his professional

contacts, Hope in some ways occupies a place of equal importance with Black, because increasing numbers of industrialists (for example, the Tennant and Macintosh group) were in a position to benefit by contact with chemistry in the universities of Scotland. The popularity of chemistry with all classes in Scotland became so great that Hope sometimes had five hundred students attending his lectures, and outside the University, interest was every bit as great. He continued to lecture until 1844, when he was succeeded by Dr William Gregory as independent professor of chemistry, fully a quarter of a century later than the foundation of an independent chair in the more highly industrialized city of Glasgow.

LONDON'S WATER SUPPLY: SAFEGUARDING ITS PURITY IN PEACE AND WAR*

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History

NO story of London's water supply would be complete without some brief account of the historical background from which have emerged the methods of purification which now form our vital defences against the transmission of the germs of water-borne disease.

Prior to the fourteenth century, the citizens of London obtained their water from the River Thames and its tributary streams, or from springs and wells, which were plentiful. At that time the supply of water was a duty of the City Corporation, and it remained so until 1582, when a Dutchman named Peter Morrys was granted a 500-year lease at the nominal charge of 10s per annum, with the right to supply water drawn from the River Thames by pumps driven by water-wheels set in one of the arches of the old London Bridge. This undertaking remained in the hands of the Morrys family until 1701, when it was transformed into a company, which also acquired the city conduits. Thus was the duty of supplying water to London relinquished by the constitutional authority and handed over to private enterprise.

The next incident of note was the construction of the New River, opened in 1613, to convey pure water from springs in Hertfordshire to the City. The success of the New River Company led to the granting of power by Parliament to other companies for the purpose of supplying water, and between the years 1669 and 1806 no fewer than seven such companies were promoted. At the time of their formation, those of the companies which drew water from the River Thames had their intakes in the tidal pool, which became increasingly polluted by the ordure of the City. This led to the succession of serious epidemics of cholera in London during the nineteenth century.

Meanwhile, however, two important measures had been taken: first, the introduction in 1826 of filtration through sand, and second, the passing of the Metropolitan Water Act of 1852, which prohibited the abstraction of water from the River Thames below

Teddington Weir and imposed, as a legal obligation, the filtration of all river-derived water and the covering of service reservoirs. The Metropolitan Water Act of 1871 further contributed to the cause of purity by the appointment of an impartial water examiner who transmitted the reports of the analyst, at the time Prof Frankland, to the Local Government Board, and who had other duties mainly inspector in nature. The water supply, however, continued to be the subject of public agitation, which culminated in the passing of the Metropolitan Water Act of 1902, by which the Metropolitan Water Board was created to take over from the companies the duty of supplying water to London.

The Act of 1902 also placed upon the Board certain duties in connexion with laboratory examination designed to ensure the safety of the supply. This was the genesis of the present Water Examination Department, which came into being in November 1905, with the appointment of Dr (afterwards Sir) Alexander Houston as the first director. There were, thus, two persons whose duty it was to safeguard the purity of the supply: first, the water examiner, who was an officer of the Local Government Board, and second, the director of water examination, who was an officer of the Metropolitan Water Board. This state of affairs continued until the appointment of water examiner was abolished in 1921, and the duty of safeguarding the purity of the supply thus devolved entirely upon the director of water examination. In 1904 the Metropolitan Water Board finally took over the private companies, and the duty of supplying water to London was taken out of the hands of private enterprise and restored once more to the control of the representatives of the people, by whom it had been voluntarily surrendered more than two centuries before.

Methods of Purification

Until 1909, filtration through slow sand filters was relied upon for the purification of the river-derived water. Sir Alexander Houston, however, was responsible for the introduction of a number of revolutionary changes, chief among which were the regular use of water which had been purified by passage through storage reservoir (1909), chlorination (1916), the use of primary mechanical filters antecedent to slow sand filtration (1923), and the use of ammonia as a means of reducing the tastes produced by chlorine alone.

The Metropolitan Water Board now comprises twelve filtration works and some sixty well stations. It supplies an area 575 square miles in extent containing more than 7,000,000 people. The water is supplied through a distribution system of pipes 8,000 miles in length. Approximately two-thirds of the water is derived from the River Thames, one-sixth from the River Lee, and one-sixth from deep wells sunk in the chalk.

The wells are usually of great depth and the water delivered from them is of excellent physical quality. For many years it was supplied without any treatment, but the increasing urbanization of the country districts around London and the excessive pumping which now takes place has led to a progressive deterioration in the quality of the water lying in the great chalk basin beneath London, and this has necessitated the chlorination of all well-derived water, but no other treatment is required.

The river waters, on the other hand, are heavily polluted and require somewhat elaborate purification

* Substance of a discourse delivered at the Royal Institution on December 8.

Briefly, the methods employed at the outbreak of war in 1939 were storage followed by filtration and chlorination.

The high rate of filtration made possible by the use of primary filters had detracted from the efficiency of the slow sand filters and had made it necessary to reinforce the purification processes at some works by the use of chlorine both before and after filtration. This prefiltration treatment has conveniently been termed 'prechlorination'.

These methods enabled the production of water in keeping with the standards of bacterial purity widely accepted prior to 1939. In that year, however, a more stringent test of purity received authoritative approval, and immediate steps were necessary to bring the water to the desired level. This involved the use of rechlorination at all filtration works, together with certain adjustments designed to render it more efficient, and an increase in the terminal dose of chlorine to a point at which it is, at times, liable to give rise to some taste in the water when it reaches the consumer. With this exception the methods have proved successful, but it will be possible to surmount the difficulty of occasional chlorinous tastes without some sacrifice in purity only by the construction of large tanks in which the water may be retained, before delivering it to consumers, for a sufficient time to enable a small dose of chlorine to do the work for which, at present, a comparatively large dose is required. The construction of these contact tanks has not been possible during the War, but it has become the accepted policy of the Board that they shall be provided when circumstances permit.

Unfortunately, chlorinous tastes are not the only ones with which water engineers are afflicted. The river waters have tastes which vary from 'earthy' to 'mouldy', the reservoirs are subject to algal growths which, by the liberation of essential oils, impart a wide range of tastes which have been variously described, the most common being 'aromatic', 'fishy' or 'grassy'. Until recently their complete elimination has been difficult or impossible, but the adaptation of activated carbon to waterworks practice has opened up a new field for the removal of tastes. Up to the present, it has necessarily been used by improvised methods, but it is hoped that it will be possible, after the War, so to adapt the works as to render this valuable treatment fully effective. The complete elimination of tastes from London's water supply should then be possible.

The Board has provided in the most ample manner or the statutory requirements in regard to water examination set forth in the Act of 1902. The laboratories in Clerkenwell which were opened in 1938 are an outstanding example of a building which, to the highest degree, combines utility with architectural and artistic merit. Every unit in the building has been designed for a special purpose, and serves that purpose with the utmost efficiency. A high proportion of the staff have devoted most of their lives to particular aspects of water analysis.

The routine control of quality is exercised by the daily examination of samples representing the water in every stage of purification. Widespread random sampling from mains and consumers' taps throughout the area of supply is also practised, and enables the quality of the water as received by the consumer to be kept under frequent observation.

During the year 1943 no fewer than 38,351 such routine analyses were made. The work of the department is, however, by no means limited to this

routine. Constant researches are made for improved methods, and special investigations are performed for the elucidation of purification and other problems which arise in connexion with the works. These have, in the past, contributed much to the sciences of water analysis and purification.

War and the Water Supply

Before describing the measures which were taken to protect the water supply of London against pollution from war damage, it would be well to picture what might have been the consequences had the water from one of the Board's major works become infected with the germs of typhoid, which is now, in England, the most to be feared of all the water-borne diseases.

Judged by past epidemics, it might be expected that infection of a filtration works of average size would, at the lowest estimate, result in 16,000 cases of typhoid with 1,600 deaths and the establishment of between 300 and 800 permanent carriers of the disease, as a reservoir of infection for the creation of further outbreaks. The significance of this can best be appreciated by comparison with the Croydon epidemic of 1937, in which there occurred 323 cases and 43 deaths. Many will recall the widespread feeling of alarm and the sense of insecurity which prevailed among those residing within the area affected by this comparatively minor outbreak.

It is easy to picture what might have been the effect upon the morale of the people of so disastrous an occurrence, and of the knowledge that each such incident would increase the probability of further similar epidemics.

High in the order of priority for protective measures came the necessity of ensuring that there should be no interruption in laboratory examination and control of the supply, for without this there would have been no means of assessing the need for, or the success of, other measures. Among the first steps to be taken were the selection of suitable buildings in comparatively safe areas and their conversion into alternative laboratories.

The use of prechlorination was extended to all filtration works. This increased the main lines of defence to four, namely, storage, prechlorination, filtration and terminal chlorination. This was undoubtedly the most important factor in preserving the purity of the water pumped from the works, for there was no occasion upon which less than two of these lines remained intact.

The residual chlorine in the water passed into supply was increased to the highest level consistent with the avoidance of serious cause for complaint. This provided against pollution through infiltration of ground-water into broken filtered-water channels and also gave some protection against failure to effect complete sterilization of fractured mains as a result of either physical difficulties, which often existed, or the fallibility of human nature. The value of residual chlorine has frequently been exaggerated, but its limitations were fully appreciated and its presence was not permitted to allow of any relaxation in the more positive methods of protection.

The possibility of the introduction of chemical poisons into the water either deliberately, or accidentally, as by the use of poison-gas bombs, was countered by a system of guards at works and reservoirs, and by arrangements for the immediate testing at the works for poisons should there be any suspicion that the water might have become contaminated.

It will be evident that chlorination was to play a most important part in our defensive measures, and it was necessary that every possible step should be taken to prevent any interruption in this vital process. Although chlorination had been in use by the Board for a considerable time, it was still regarded as somewhat subsidiary to the older purification processes. This view had now to be revised, for acts of war might at any moment have rendered it the most important or, indeed, the only barrier against the spread of water-borne diseases. A wholesale programme of reconstruction was planned and received the immediate approval of the Board. This work involved the detailed consideration and replanning of more than 150 chlorination points.

There could be no doubt that the most serious danger would be created by the fracture of water mains and sewers in close proximity in the streets, resulting in the admission of sewage to the water mains. Protection against the consequences of such incidents was provided by the rapid closure of valves by turncocks and by instructions to the effect that no main should be put back into supply after repair until it had been thoroughly flushed and disinfected by chlorine. Whenever possible, repaired and sterilized mains were examined bacteriologically before being restored to supply, but frequently they were so urgently required for fire fighting that this could not be justified. Sterilization by chlorine was, however, never omitted. Special mobile chlorinators were provided, and the whole of London was divided into areas to each of which some were allotted. Central control was maintained and a reserve of chlorinators was held directly under my orders, thus enabling relief to be provided in districts where the work was exceptionally heavy. Some difficulties in the rapid sterilization of mains were encountered in the early days, due chiefly to the almost complete disorganization of communications, but these were rapidly overcome and, as experience was gained, the whole organization worked smoothly and without avoidable delay.

It was not only necessary to conserve the purity of the supply. When the enemy resorted to fire raising, quantity became second only in importance to purity, for, without water, London might have been destroyed by fire. The greatest need for water frequently coincided with heavy damage to the works and consequent limitation of their output. Decisions had to be taken, often on the spur of the moment, as to the extent to which orthodox methods of purification might be discarded to increase production without imperilling the health of the people. There is no hard and fast line between a safe and an unsafe water, and such momentous decisions were not easily taken, for they had, of necessity, to be based upon personal opinion. It must be admitted that the taking of them was assisted by the gravity of the situation, and it can fortunately be said that there was no occasion when the quantity of pure water available was insufficient nor was there, at any time, any deterioration in its bacterial purity. Local shortages there were, but these were due to the immense damage to the mains, and this was remedied with remarkable rapidity by the engineering staff of the Board.

Emergency Water Supplies

It was evident that, whatever precautions might be taken, interruption of piped supplies might occur. Arrangements were therefore made to deliver pure

water by tank wagons and to provide emergency supplies if necessary from private wells and casual surface water sources. An organization was set up for the purification of these waters, which entailed the training in emergency purification methods of more than 7,000 volunteers.

During the aerial attacks on London, almost every conceivable form of damage which might have prejudiced the purity of the supply was inflicted upon the undertaking. Damage to sewers in the outskirts of London necessitated the discharge of untreated sewage into the rivers from which raw water supplies were drawn, reservoirs were cut off from the works by the destruction of aqueducts, thus necessitating the passing of unstored raw river water on to the filters. Bombs fell into the filter beds and caused short circuiting between the unfiltered and the filtered water channels. At times it was necessary to bypass the slow sand filters to enable the supply for fire fighting to be maintained. Damage to the distribution system was particularly severe. In one night alone, more than five hundred mains were fractured and many became heavily charged with sewage.

All the necessary protective measures were, however, in readiness, and there is not a shred of evidence that the water supplied to London was at any time less safe than before the War. During the four years 1940-43, bacteriological analyses were performed on more than 50,000 samples drawn at the works, from mains pumping water into supply and throughout the distribution area, particularly in those localities where bomb damage had been heavy. Of these 50,000 samples, 99.3 per cent showed the absence of *Bact. coli* in 100 ml., that is to say, they conformed to the highest standard of bacterial purity despite the extensive damage which was frequently inflicted and the many opportunities for dangerous pollution which were created. This represents a purity, during these years of war, higher than ever before, and it has never been suggested by any health authority that a single case of disease occurred in London which might have been attributed to the water supply.

POLYMER-PLASTICIZER INTERACTION

By ELIZABETH M. FRITH and R. F. TUCKETT
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AT a meeting of the Plastics Group of the Society of Chemical Industry on November 17, 1944, polymer-plasticizer interaction was discussed. Owing to the wide range of the discussion and in view of topical interest in this subject, it has been thought desirable to present here a preliminary account which covers some of the points raised, more detailed papers will appear elsewhere. Some such general account seems to be overdue, as previous ideas on the subject would seem to need revision as a result of recent advances in polymer thermodynamics.

Though all thermoplastic polymers soften on heating, they also, in common with other organic compounds, tend to decompose as well. Moulding temperatures for any particular polymer must therefore be chosen to suppress this decomposition as much as possible. Some polymers can be moulded with negligible decomposition, whereas with others the temperatures required for moulding are too high,

ven with the intelligent use of anti-oxidants. Historically, plasticizers were first used in a systematic manner in order that intractable polymers might be moulded at temperatures which were not too damaging, their purpose was to make the composition more plastic (or less viscous) at a given temperature, and the name 'plasticizer' perpetuates this property, though the fact that the elastic properties were also profoundly altered was soon realized.

To explain the action of plasticizers, it is necessary to start with the current picture of an amorphous polymer, which is that of a tangled collection of randomly kinked long-chain molecules, if certain reasonable assumptions are made about the flexibility of each chain, this qualitative picture can be transformed into a formal model in terms of which many of the observed properties of polymers can be described. These properties are a consequence of the tangled structure, and the effect of a plasticizer is reasonably to break down or loosen this structure. Early theories of plasticizer action, allowing for this, suggested that the plasticizer acted as an 'internal ball-bearing' or lubricant by virtue of which neighbouring portions of polymer could slide over each other more rapidly. Though satisfying to the mechanically minded, the physical chemist finds such a picture inadequate, for, besides not accounting for the specificity of plasticizers, it completely avoids the crucial problem of how the plasticizer is distributed throughout the polymer. Is it a discrete physical mixture, like sand and sugar, or does dispersion on a molecular basis form a solution of plasticizer in polymer? In fact, any mechanical theory leaves for later consideration whether the 'ball-bearing' is a single molecule, a discrete visible droplet or anything between these two extremes.

It is now realized that plasticizers can belong to either of the above two main classes these being termed non-solvent and solvent types respectively. Two of the oldest plasticizers for nitro-cellulose form conveniently contrasting examples of these. Castor oil is a non-solvent plasticizer and is dispersed in the nitrocellulose as discrete droplets which are sometimes visible with a microscope, many rubber 'stenders' also come into this category. As a result of internal diffusion in the plastic, droplets of non-solvent types will tend to coalesce to larger aggregates and ultimately to 'sweat out'. On the other hand, a typical solvent plasticizer for nitrocellulose is camphor, this is dispersed as single molecules forming a true solution, in contrast to the two-phase system of the non-solvent type. For the above reasons, solvent plasticizers are preferable for nearly all purposes, and these are now discussed further. At the moment, only amorphous polymers and amorphous plasticizers are considered.

Previously it has been hard to accept the idea of a plasticizer dissolving in a polymer owing to difficulties in visualizing the nature of the solution. To disperse a plasticizer molecularly, it was thought necessary to assume a specific attraction between the plasticizer molecule and the polymer unit, many references to a polymer-plasticizer complex being found in the literature. Similarly, the physical fact that raw rubber swells and finally dissolves in a solvent like benzene tends to reinforce the view that there is a relatively strong polymer-solvent interaction compared with the polymer-polymer one, and that this is the main factor influencing the swelling and solubility of macromolecules.¹ Recent work has tended to deny this view completely, and also explains why

different plasticizers have different compatibilities with a specific polymer.

From the point of view of solubility, a polymer is now considered as a liquid, hence polymer-plasticizer (or polymer-solvent) mixing is exactly similar to that of two simple liquids and subject to the same thermodynamic principles. Two liquids will mix to form a single phase only if there is a decrease in Gibbs free energy as a result of the mixing process, that is, $\Delta G < 0$. Now, the decrease in Gibbs free energy can be split into the usual heat term and entropy of mixing term ($\Delta G = \Delta H - T\Delta S$). In the case of a polymer dissolving in a solvent, experiment reveals that ΔS is generally abnormally large and positive. The theoretical reason for this was first suggested by Meyer², it is due to the fact that a long-chain molecule in solution can take up a large number of distinguishable configurations. This circumstance alone provides a large positive mixing entropy which is sufficient by itself to bring about solution. A polymer-plasticizer complex (and similarly a solute-solvent one in a liquid mixture) means that the heat term ΔH is strongly negative and therefore assists solution, instead of being positive as it is for most binary mixtures ($\Delta H > 0$ corresponds to absorption of heat on mixing). With polymers, the presence of a large positive ΔS means that it is unnecessary to invoke any specific interaction with the plasticizer to explain the solution process.

Meyer's original suggestion was formalized into a definite model the statistical thermodynamics of which were worked out independently and simultaneously by Flory³, Huggins⁴ and Miller⁵ for the case $\Delta H = 0$ with essentially similar results, the more difficult extension for $\Delta H \neq 0$ has recently been made by Orr⁶ and Guggenheim⁷. The results show that, provided ΔH is not too large, ΔS is almost independent of it (A similar result holds for simple liquid mixtures and is the basis of Hildebrand's regular solution approximation⁸). It follows from this that if ΔH is strongly positive, then ΔG can also become positive, hence the mixture of polymer and plasticizer will separate into two phases. The theory predicts that one of these will be swollen polymer and the other almost completely pure plasticizer, in agreement with experiment⁹. Hence, at a given temperature, the composition of the swollen phase is the maximum amount of plasticizer which can be incorporated in a polymer for that specific pair of substances. Any excess plasticizer will 'sweat out' and form a separate phase similar to a non-solvent plasticizer. It seems possible that some of the evidence in the literature of polymer-plasticizer complexes containing 20-30 per cent plasticizer may be due to incompatibility effects of this type.

The problem has thus resolved itself into a measurement of the heats and entropies of mixing (or dilution) of a polymer with a plasticizer, with the emphasis on the heat term. In theory, relative vapour pressure measurements of the plasticizer in the polymer will give all the required information, provided a sufficiently large concentration and temperature range is covered. The heats involved are, however, small and therefore subject to large relative errors, even under the most favourable conditions, as in Gee and Treloar's classic study of the rubber-benzene system¹⁰, the probable error in the estimated heat of dilution is ± 30 per cent¹¹. In studying differences between plasticizers, which are usually chosen to have a very small vapour pressure, this line of attack is distinctly unpromising and will remain so until

pressures of 10^{-2} – 10^{-4} mm can be measured with as much precision as those of 10–100 mm. Direct measures of the equilibrium swelling or the total heat of mixing are difficult with 'hard' plastics, such as polyvinyl chloride, as equilibria are reached very slowly.

For the above reasons, it has been necessary to develop indirect methods of estimating ΔH , and even so, only relative results can be obtained. One method relies on the assumption that the polymer-plasticizer heat of mixing is proportional to the corresponding monomer-plasticizer heat effect. This is a pure assumption, though a reasonable working one, and can perhaps be checked later by heat of dilution measurements on a low polymer. The problem then becomes a measurement of the mixing heats between plasticizer and monomer, which is feasible experimentally, with vinyl polymers, the saturated monomer is preferred to avoid double-bond complications, for example, ethyl benzene for polystyrene. A second method uses the concentration variation (c) of the specific viscosity (η_{sp}) of dilute solutions of polymers as a measure of ΔH . Alfrey, Bartovics and Mark¹² found that, for a given polymer, both the limiting value of η_{sp}/c at zero concentration and the slope of the $\eta_{sp}/c - c$ line were dependent on the solvent, 'good' solvents increased both the slope and the intercept, whereas 'bad' ones depressed them. The concept of 'good' and 'bad' solvents can be formulated thermodynamically and a semi-quantitative treatment of the viscosity effects has been developed.¹³ It is not often possible to measure dilute solution viscosities in pure plasticizers, to get over this difficulty, the polymer is dissolved in a mixture of 'indifferent' solvent ($\Delta H = 0$) and plasticizer. The slopes of the $\eta_{sp}/c - c$ lines vary with the plasticizer used in the solvent mixture and are in agreement with their known plasticizing properties with a given polymer. Though the theory of the effect is admittedly not complete, the method is probably the most convenient one for estimating relative interactions. The light scattering of polymer solutions¹⁴ is a possible means by which interactions might be studied in the future, but the technique is still in its infancy, the published results suggest a strong dependence of the effect on solvent type.

So far, discussion has been confined to polymers which are completely amorphous. For crystalline bodies, the total free energy change for the solution process can be split into two stages: (1) melting of the crystals to give an amorphous polymer (ΔG_{melt}), (2) mixing of the amorphous polymer with the plasticizer (ΔG_{mix}). For amorphous polymers, (2) is the only relevant process and the factors governing ΔG_{mix} have already been discussed. If the melting range of the crystalline polymer is above room temperature, then ΔG_{melt} will be positive, its magnitude will depend on the interval between room temperature and this range. For a high-melting polymer ΔG_{melt} can become larger than ΔG_{mix} for most solvents, in which case the crystals will be completely insoluble at low temperatures, as the total free energy change is positive. For this reason, crystalline polyethylene is insoluble in nearly all solvents at room temperature. As the temperature is raised, the melting range is reached in which there is an appreciable proportion of amorphous material in thermodynamic equilibrium with the crystalline regions¹⁵, this amorphous polymer is miscible with solvents, and the rapid increase in polyethylene solubility in nearly all solvents at about 70° C is

due to the operation of this factor. In such circumstances, a plasticizer will tend to dissolve in the amorphous regions and leave the crystalline ones untouched, only a strong relative attraction ($\Delta H < 0$) between plasticizer and polymer link will cause the crystalline regions to dissolve.

In the foregoing paragraphs, an attempt has been made to give the thermodynamic background of the polymer-plasticizer compatibility problem. Such an approach does not give any information at all about the relative plasticizing efficiency of two compatible substances—this is not surprising as it forms a completely unrelated problem. The efficiency of a plasticizer is now suspected to be almost completely determined by the size and shape of its molecule, but a large amount of accurate data is required before this problem can be pursued further.

¹ Gee, *Trans Inst Rub Indust*, **18**, 266 (1943)

² Meyer, *Helv Chim Acta*, **23**, 1063 (1940)

³ Flory, *J Chem Phys*, **10**, 51 (1942)

⁴ Huggins, *Ann N Y Acad Sci*, **43**, 1 (1942)

⁵ Miller, *Proc Camb Phil Soc*, **39**, 54, 131 (1943)

⁶ Orr, *Trans Far Soc*, **40**, 320 (1944)

⁷ Guggenheim, *Proc Roy Soc A*, **183**, 203, 213 (1944)

⁸ Fowler and Guggenheim, "Statistical Thermodynamics", 356 (1939)

⁹ Bronsted and Volquartz, *Trans Far Soc*, **35**, 571 (1939)

¹⁰ Gee and Treloar, *Trans Far Soc*, **38**, 147 (1942)

¹¹ Gee, *Ann Rep Chem Soc*, **17** (1942)

¹² Alfrey, Bartovics and Mark, *J Amer Chem Soc*, **64**, 1557 (1942)

¹³ Frith, *Trans Far Soc*, **41**, 17, 90 (1945)

¹⁴ Doty, Zimm and Mark, *J Chem Phys*, **12**, 143 (1944)

¹⁵ Frith and Tuckett, *Trans Far Soc*, **40**, 251 (1944) Richard *Trans Far Soc*, in the press

OBITUARIES

Dr. D. S. Raitt

THE tragic death of Douglas Raitt as the result of a motor accident on October 4, 1944, at the early age of forty-one, will be deeply regretted not only by marine biologists but also by the general public for apart from his scientific attainments, he had wide cultural interests and was recognized as a successful broadcaster and as a composer of Scottish song. In particular, fishery research has lost a most promising worker, who had a brilliant career before him.

Born in Aberdeen on January 18, 1903, Raitt was educated at Robert Gordon's College there and at the University of Aberdeen. In the University he came under the influence of Prof J. Arthur Thomson who undoubtedly did much to foster in him originality, precision in workmanship and a philosophical outlook on life. Immediately after graduating B.S. in 1926, he was appointed a probationer naturalist on the scientific staff of the Fishery Board for Scotland, being placed on the established grade two years later.

With the resumption of fishery research after the War of 1914–18, the study of haddock in all its aspects was delegated to Scotland by the International Council for the Exploration of the Sea, and Raitt joined the Scottish team of workers so ably led by Dr A. Bowman, then scientific superintendent. His first contribution to the series of publications was on the fertility of the haddock. After the transfer to Newfoundland of Dr Harold Thompson who had carried out brilliantly the survey of the haddock material and laid the foundation of the work, Dr Raitt was given the task of continuing the research and producing forecasts of the future yield of the stocks, largely for the benefit of the fishermen and the trade. This led to the appearance of a series

f valuable papers published by the International Council and by the Fishery Board for Scotland (now the Fisheries Division, Scottish Home Department), two of the most important being "The Haddock Stocks of the North-East Atlantic" and "The Rate of Mortality in the North Sea Haddock Stocks"—the latter a definite contribution to the overfishing problem. These researches gained for him the D.Sc. in 1937. In 1939 he was appointed Buckland lecturer for 1940 to deliver a series of lectures on the haddock, but owing to the outbreak of war the lectures were never delivered.

Raitt was a fellow of the Linnean Society and of the Royal Society of Edinburgh and published papers in various aspects of marine life in different scientific journals. In one of these he described a new species of sandeel from British waters—no mean achievement these days.

He had a great gift for organizing and staging shows and was largely responsible for two fishery exhibits put up by the Fishery Board for Scotland at Aberdeen and Glasgow, which were designed to illustrate the practical aspect of marine research as carried out by a Government department. The film "Sea Food", a record of the methods carried out at sea by the research vessels and in the laboratory, was also supervised by him.

During the present War, he was seconded to the Ministry of Home Security and held important posts under the district commissioners at Inverness, Edinburgh and Dundee.

He is survived by Mrs Raitt and two sons.

R. S. CLARK.

Prof Gustav Cassel

PROF GUSTAV CASSEL, whose death at the age of seventy-eight occurred on January 14, was beyond doubt one of the outstanding figures in economic science during the inter-war period. His authority was second only to that of Lord Keynes, and his advice was eagerly sought on many occasions by his own Government and by foreign Governments. He played an active part at many international monetary conferences during the 'twenties and early 'thirties, and was head of the Swedish delegation to the World Economic Conference of 1933.

Prof Cassel occupied the chair of economics at the University of Stockholm, and his "Theory of Social Economy" will always rank with the outstanding works on economic theory. First and foremost, however, he was a monetary specialist. His most important contributions to economic science were in the monetary sphere. In particular, he secured his place in posterity as the leading theoretical expert on foreign exchange during the chaotic period that followed the War of 1914-18. In his "Money and Foreign Exchange After 1914", he put forward the theory that under a system of inconvertible paper currencies the exchange-rates tend to represent the ratio between the internal price levels of the countries concerned, in other words, they tend to adjust themselves towards what he called their "purchasing power parities". When he first sought to popularize his conception, it was regarded as almost revolutionary, and the time-honoured theory according to which exchange-rates are determined by the trade balance died hard. He lived to see, however, the general acceptance of his principle.

In the sphere of monetary policy, Cassel was strongly opposed to deflation, and advocated low

interest-rates during the late 'twenties and early 'thirties. As a member of the Gold Committee of the League of Nations, and in his various writings, he was concerned by the inadequacy of the volume of monetary gold to meet the requirements of expanding world production and trade. In 1937, however, Prof Cassel, together with many other theoretical and practical experts, was misled by an apparent excess of gold supplies into a panicky advocacy of a deflationary policy.

Prof Cassel did not believe in the device, so popular among many economists, of seeking to impress his readers by indulging in obscurantism. His books and articles were written for the most part in simple, clear language, understandable to the intelligent layman at the same time as being inspiring to the expert.

P. EINZIG

Mr E. Rothbart

ERWIN ROTHBART, acting lecturer in economic statistics in the University of Cambridge, who was killed in action in Holland in December 1944, aged thirty-one, was a refugee from Nazi Germany and an expert in economic theory and statistics, he specialized in the theory of industrial fluctuations and economic development.

Despite his originality, he had published little. His reticence and his horror of superficiality were such that his best work is probably to be found in the mass of unpublished manuscripts which he left. Some of these may be rescued for publication, but undoubtedly the more subtle of his ideas were still locked away in his mind. The quality of his thought was revealed in the penetrating book-reviews which he contributed to the *Economic Journal*, and in the formal and informal discussions on economic theory in which he took part with the younger economists at Cambridge and London.

Rothbart first became prominent in discussions in 1936 at the meetings held regularly by Profs Robbins and Hayek at the London School of Economics. There, with A. P. Lerner, O. Lange, N. Keldor and M. Kalecki, he found himself one of a small group championing the latest theories of J. M. Keynes with an almost religious insistence. Two years later he was appointed research assistant in economic statistics at Cambridge, and in 1940 he took over the teaching of economic statistics, and continued it until he insisted on joining the Army.

Rothbart was a fine example of that combination of opposites, which is the rule rather than the exception in the workings of the human mind. Quick in thought, he was slow in action and self-expression. A self-taught mathematician, he delighted in the subtler turns of economic theory, yet his awareness of practical and political realities was no less acute. A lover of liberal values, his political sympathies were nearer to the hard discipline of the communists. With an impish love of life, he combined a recklessness that courted death. He leaves a widow and young son.

D. G. CHAMPERNOWNE

WE regret to announce the following deaths.

Dr. Alexander Duckham, chairman and governing director of Alexander Duckham and Co., Ltd., lubrication technologists, on February 1, aged sixty-seven.

Prof S. H. Gage, since 1908 emeritus professor of histology and embryology at Cornell University, on October 20, aged ninety-three.

NEWS and VIEWS

Sir John Orr, F.R.S., and the Rowett Research Institute

SIR JOHN BOYD ORR's wide circle of friends will greatly regret that he has tendered his resignation from the directorship of the Rowett Research Institute after holding that post since its foundation, in which he took a prominent part. All over the world it is recognized that to a very large extent it was his vigorous and stimulating direction that made "the Rowett" one of the outstanding research centres where problems relating nutrition to agriculture have been studied. The wide recognition to-day that planned agriculture is the only sound foundation of a national nutrition policy is one direct result of Sir John's teaching and influence. His ideas prompted the appeal for "the marriage of agriculture and nutrition" that the Right Hon Stanley Bruce made to the League of Nations on an historic occasion. They can be regarded, therefore, as having been prominently in the mind of those who called together the United Nations Conference on Food and Agriculture at Hot Springs, Virginia, in 1943. Whatever benefits to the world at large may ultimately be derived from what happened at that great conference will be related in the minds of many people with the views that have dominated everything that Sir John Orr has said or written during the past twenty years.

Sir John's own research has been mainly of protein and mineral metabolism, but he is perhaps best known to the general public for his published works on the nutritional needs of the people of Great Britain. A very deep impression was made just before the War by the appearance of his book "Food, Health and Income". The data presented in this work have been used by sociologists all over the world, but, perhaps, no more important use has been made of them than when they were adopted as a background against which a nutritional policy for Great Britain during the period of the War was planned. Among Sir John's many contributions to the advancement of nutritional science, there can be mentioned his establishment at the Rowett Research Institute of the Imperial Bureau of Nutrition and his foundation of *Nutrition Abstracts and Reviews*, of which he has been editor-in-chief since it first appeared. Sir John has been a member of many international and national committees dealing with matters concerning nutrition, more particularly in its relation to agriculture. He took an active part in the deliberations of the Technical Commission on Nutrition of the League of Nations and helped to draw up a number of the invaluable reports this Commission issued from Geneva. He served on the Advisory Committee on Nutrition of the Ministry of Health before the War and has since acted as chairman of the Scottish Scientific Advisory Committee. He was recently elected by a group of United States men of science to receive an award for the most outstanding work in the international field of nutrition. There will be everywhere an earnest hope that Sir John will continue to exert, perhaps in other spheres, the same powerful influence that he has exerted in the past. A great deal of enterprise and effort will be needed if the recommendations and resolutions of the Hot Springs Conference are to be implemented, even in the countries where the attitude of the politicians and the public is relatively enlightened

towards social and economic problems. We understand that no successor at the Rowett Research Institute to Sir John Orr has yet been elected, but the post, which also carries with it the directorship of the Imperial Bureau of Nutrition and the editorship of *Nutrition Abstracts and Reviews*, will be advertised in due course.

Sir William Wright Smith

ON February 2, at the Royal Botanic Garden, Edinburgh, Sir William Wright Smith, King's Botanist in Scotland, regius keeper of the Royal Garden, and professor of botany in the University, was presented with a portrait of himself, on the occasion of his seventieth birthday. Sir John Stirling Maxwell presided, and the presentation was made by the Earl of Stair. At the same ceremony a second portrait of Sir William was presented to the Botanic Garden by Sir John Fraser. The portraits, which were painted by Mr Stanley Cursiter, were the gift of a large number of Sir William's botanical and horticultural colleagues and other friends. Sir William has been connected with Edinburgh since the beginning of his career. He was educated at the University, and was lecturer in botany there during 1902-7. In 1908 and 1909, he explored the vegetation of north-west Sikkim, and of the Tibet-Nepalese and the Sikkim-Chumbi frontiers, returning to Edinburgh in 1911 as assistant keeper of the Garden, in 1922 he was appointed regius keeper and professor at the University. Sir William's early explorations have given him a life-long interest in the mountain flora of India, Tibet and Nepal, and it is for his work on the classification and introduction of plants from these regions, notably primulas and rhododendrons, that he is best known to botanists and horticulturists all over the world. Under his genial direction, the great traditions of the Edinburgh Garden, and of the University Botanical Department, have been worthily upheld, and his many friends have welcomed this opportunity of showing him their admiration and affection.

Institution of Electrical Engineers

Faraday Medallist

THE Council of the Institution of Electrical Engineers has made the twenty-third award of the Faraday Medal to Dr Clifford Copland Paterson, past-president, for the conspicuous services rendered by him in the advancement of electrical science, particularly in the field of electrical research. The Medal is awarded not more frequently than once a year either for notable scientific or industrial achievement in electrical engineering or for conspicuous service rendered to the advancement of electrical science without restriction as regards nationality, country of residence or membership of the Institution. On the staff of the National Physical Laboratory during 1903-19, Dr Paterson took charge of the electro-technical and photometric departments and was largely responsible for building up this section of the Laboratory. During the War of 1914-18 he participated in the inception and development of the Paterson-Walsh electrical height finder, which provided an automatic record of the heights of aircraft. He has been director of the Research Laboratory of the General Electric Company at Wembley from its inception, guiding the whole of its activities, which range from the heavy engineering field to electronics. His contribution to investigations into new methods

of artificial lighting and into electronic developments has been outstanding. During the present War he has collaborated with the Armed Forces and with the Supply Departments on many matters of outstanding national importance. Dr Paterson was elected a fellow of the Royal Society in 1942.

Honorary Member

THE Council of the Institution of Electrical Engineers has elected Mr John Somerville Highfield, past-president, to be an honorary member of the Institution. This distinction has been conferred upon him in appreciation of his distinguished work in the development of the science of the supply and application of electricity. Mr Highfield became chief engineer to Stafford and St Helens, Lancashire, after which he was appointed chief engineer and manager of the Metropolitan Electric Supply Company. As senior partner in the firm of Highfield and Roger Smith, he later acted as consulting engineer for the Central Electricity Board and several large electricity undertakings and industries in Great Britain and abroad. He also became a director of the London Power Company, the London Associated Undertakings, the Central London Electricity Ltd, etc. Mr Highfield originated the closed-bar system for switchgear, discovered the reason for the failure of high-voltage alternator windings, and introduced to England the Thury system of high-voltage D.C. constant-current generation and distribution. During the War of 1914-18 he demonstrated at sea the use of shrouded hydroplanes for submarine detection.

Engineering and the Future

MR FRANK PARFETT delivered his second presidential address before the Society of Engineers on February 5. He stated that there is a widespread and growing opinion among professional engineers in favour of federation of their institutions in order to have co-ordination of policy and joint representation on matters which are common to the whole profession. During the past year, two committees, the members of which came from various institutions, have been concerned with this matter, one of them dealing with national and the other with international federation. Very shortly proposals will be circulated to the councils of the bodies concerned for their consideration. Referring to the possibility of conscription after the War, Mr Parfett said that the problem for peace-loving nations when war comes is to be ready and active with the minimum time-lag. The training of engineering personnel must therefore not be wasted. Young engineers in the future who are required to have army training should be sent to military engineering centres, and at the end of their term they should be entered on the National Register according to the sphere in which they could best serve the country in a national emergency. Factories, means of production, and personnel should be so organized that in the event of war we can immediately change from peace production to war production. Among post-war improvements suggested by Mr Parfett was that of road and street lighting. He believes that main and secondary roads throughout Britain should be so illuminated that individual lighting on road vehicles would be unnecessary and merely reserved for minor roads. In all general utility articles, the public should accommodate itself to the acceptance of mass-produced articles from standardized designs. This would allow methods of

production to be improved, which is the only way in which industry will be able to meet the higher wages now being demanded. Mass production does not mean the death of individual craftsmanship, for which there is still ample scope.

Conference on Science in War

THE Association of Scientific Workers is holding a Conference on "Science in Peace" on February 17-18 at the Caxton Hall, Westminster. The Conference is being organized in three sessions. The first, on Saturday afternoon, will deal with ways of securing an expanding economy and full employment. The problems of the effects of science on the productivity of labour will be introduced by a member of the Amalgamated Engineering Union, and specialists in each field will discuss in detail how science can be used to develop the basic British industries. The second session will deal with the more internal problems of science. The needs of fundamental research, and of applied science and technology will be dealt with, and papers will be read on the training of scientific workers, the organization and finance of science and information services. The third session will deal with the way in which science can affect the everyday life of each individual. The topics to be covered are research into consumer needs, health, food and agriculture, building and homes, and the place of science in culture. Tickets for the Conference (5s for the three sessions, 2s 6d per session) and further information can be obtained from Mrs B. Ryerson, Association of Scientific Workers, Hanover House, High Holborn, W.C.1.

Announcements

DR HARLOW SHAPLEY, director of Harvard College Observatory, has been re-elected to the presidency of the Society of Sigma Xi, the American society for the encouragement of research in science. Dr Frank B. Jewett, president of the National Academy of Sciences, has been elected member of the Society's national executive committee and Dr M. C. K. Jones, of the Esso Research Laboratories, Elizabeth, N.J., is to be a new member of the national membership committee.

DR B. A. KEEN, scientific adviser to the Middle East Supply Centre, has completed a second extensive tour of Middle East territories. He has now returned to England for further consultations, and the completion of his report on the problems of agricultural and rural development in that area.

DR J. P. LAWRIE, senior press censor, Scientific and Technical Censorship, Ministry of Information, has, after five years service, resigned his appointment in order to take up new duties with the Royal Naval Scientific Service.

DR HENRY DE LASZLO, managing director of L. Light and Co., Ltd., Old Bowry Laboratories, Wraybury, fine chemical manufacturers, is visiting the United States, Mexico, Portugal and Spain. He will be making a survey of sources of organic intermediate chemicals manufactured in the United States, arranging for contracts for future delivery, and purchasing out of the way organic research chemicals not manufactured in Great Britain. Research workers and others requiring any particular substance are invited to communicate with Messrs. Light.

LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications.

Sub-crystalline Changes of Structure Accompanying Thermal Transitions in Rochelle Salt, and in Potassium Dihydrogen Orthophosphate

ACCORDING to the classical derivation of the Phase Rule, a transition point in a one-component system involves the co-existence of three independent phases, with the same thermodynamic potential of the component in three independent equations of state. For equilibria involving two solid and one vapour phase, the requirement that the phases shall be 'independent' can be given a definite interpretation in terms of crystal structure. For example, if we start with a single crystal of rhombic sulphur, and gradually heat it to above the transition point with monoclinic sulphur, the crystal may appear to preserve its external form, but X-ray photographs would show that actually it breaks up into a mass of smaller crystals of the monoclinic variety. These would give powder rings with the monoclinic spacings, insofar as they are independent of the original rhombic lattice. Corresponding with this rearrangement of the molecules to form a new crystal structure independent of the original arrangement, there are finite changes of volume and heat content at the transition temperature between the two crystal forms.

Thermodynamic transitions involving changes from one crystal structure to another at a transition point are said to be 'of the first kind'. We would prefer to call them 'discontinuous'. X-ray pictures illustrating the change from single crystal to powder have been published for the change from β - to α -resorcinol¹, and have also been observed² for the change of structure in KD_2PO_4 .

An increasing number of examples is accumulating³ of thermodynamic transitions 'of the second kind', which might be termed 'continuous'. In these, finite changes of volume and heat content at a transition point are replaced by 'anomalous maxima' on the expansion and specific heat curves, as if the phase change were spread out over a range of temperatures. Although some of these phenomena have been interpreted by statistical thermodynamics, it has not hitherto been clear how 'continuous' transitions affect crystal structure.

We have found in the case of Rochelle salt⁴, and more recently in the case of potassium dihydrogen orthophosphate, that a break-up of the single crystal into sub-crystalline regions actually does occur over the transition range of temperatures. These sub-crystalline regions are, however, orientated in a definite relationship to the original crystal, and the discontinuities between them appear to be insufficient to lead to the formation of independent small crystals. Moreover, the break-up is reversible, in the sense that if the crystal is heated above the transition range again, X-ray pictures show that the sub-crystalline regions coalesce, and that the specimen again possesses all the properties of a single crystal. A single crystal broken up in this way may conveniently be called a 'hybrid'.

Up to the present, observations have been made by oscillating single crystals in a low-temperature

chamber, at a series of temperatures, and making accurate determinations of changes in lattice spacing by means of a multiple-exposure spectrometer. Changes in intensities of X-ray reflexions have also been observed, but will not be described here.

For Rochelle salt, over the transition range which begins at $+24.5^\circ\text{C}$ and terminates at about -20°C , no break-up of single crystals is observed when reflexions from planes parallel to the c axis are measured. But reflexions from planes parallel to the a axis and approximately bisecting the angle between the b and c axes are split into two components of slightly different Bragg angle. These two components are most clearly separated at about the middle of the transition range, around 0°C . Their presence shows that over the transition range a 'single' crystal of Rochelle salt is in reality made up of sub-crystalline units, which all have their a axis in common, and their b and c axes respectively equal but which differ in that the angle between these two axes is either $90^\circ 2'$ or its supplement $89^\circ 58'$ apparently at random. These b and c axes coincide approximately in magnitude and direction with the b and c axes of orthorhombic Rochelle salt above 24.5°C .

It is noteworthy that if the 'single' crystal is cooled below about -20°C , or is heated above 24.5°C the split reflexions coalesce again. The change from a single crystal to a hybrid crystal with these sub-crystalline domains can be brought about repeatedly by the appropriate temperature changes, though there is some evidence that with repeated treatment the size of the sub-crystalline unit decreases.

In the case of potassium dihydrogen orthophosphate, when a single crystal is cooled below the transition threshold⁵ at -158°C , by dripping liquid oxygen (-185°C) or liquid nitrogen (-195°C) or to it, a corresponding break-up into sub-crystalline units is observed, which is even more striking in order of magnitude. When reflexions from planes parallel to the a or b axes are examined, the crystal appears to be 'single' down to the lowest temperatures so far observed. On the other hand, a break-up into sub-crystalline units is apparent at both -185°C and -195°C when the crystal is viewed normal to the c axis. The sub-crystalline units all have the c axis in common, and their a and b axes are equal to each other, and approximate in direction and magnitude to the original axes in the tetragonal form. But the angle between these two axes can be either $90^\circ 27'$ or its supplement $89^\circ 33'$, apparently at random. As with Rochelle salt, the change from single crystal to hybrid and back again can be brought about repeatedly by the appropriate temperature changes.

Further details of the structure of these hybrid single crystals are being examined. But even the experimental evidence so far obtained offers a suggestive picture of the structural basis of continuous thermodynamic transitions. It seems likely that when the change of crystal structure which would be involved in the appearance of a new phase is sufficiently small to be accommodated within the original lattice by a sub-crystalline break-up, the single crystal changes into a hybrid, instead of breaking up into new crystals. From the point of view of the Phase Rule, no new equation of state independent of the original structure can be formulated, so that there is no sharp transition point.

It is hoped that further experiments on these hybrid single crystals will throw light on the hysteresis which frequently accompanies continuous thermo-

dynamic transitions, and also on the formation of thermal mosaics' in crystals'

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London, W 1 Dec 20.

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Raman Spectrum of Diamond

THE new approach to the dynamics of crystal lattices made by Sir C V Raman¹ leads in the case of diamond to the result^{2,3} that the atomic vibration spectrum of this crystal should exhibit *eight* distinct monochromatic frequencies. Of these, the highest frequency ($1,332\text{ cm}^{-1}$ in spectroscopic units) corresponds to the triply degenerate vibration of the two bravais lattices of the carbon atoms with respect to each other, this being *active* in the Raman effect. The other seven frequencies represent oscillations of the layers of carbon atoms parallel to the faces of the octahedron or the cube occurring normal or tangential to these planes with the phase reversed in each successive equivalent layer. All the seven modes of vibration of this description are *inactive* in the Raman effect as fundamentals. The *octaves* of these frequencies may, however, appear as frequency shifts in the Raman spectrum, though with intensities extremely small compared with that of the Raman line of frequency shift $1,332\text{ cm}^{-1}$. Besides the octaves, various combinations of these frequencies may also appear in the Raman spectrum.

The new lattice dynamics thus predicts that besides the frequency shift of $1,332\text{ cm}^{-1}$ corresponding to the so-called principal or fundamental oscillation, numerous other frequency shifts appearing as sharply defined lines should manifest themselves in intensely exposed Raman spectra of diamond. This result has been strikingly confirmed in an investigation already reported by me⁴. Since then, I have recorded spectra of much greater intensity and much better resolved, with the aid of a large quartz spectrograph and an exceptionally large plate of diamond of the ultra-violet transparent type recently acquired by Sir C V Raman. Under the conditions employed and using the 2536 Å resonance radiation from a water-cooled magnet-deflected mercury arc in quartz as the exciter, the Raman line with frequency shift $1,332\text{ cm}^{-1}$ is recorded with an exposure of only 10 minutes. With an exposure of 72 hours, a satisfactory picture showing what may be designated as the Raman spectrum of the *second order* is obtained. This is the upper spectrum shown in the reproduction

herewith, the lower spectrum being that of the mercury arc recorded with comparable intensity. It will be noticed that a whole series of discrete Raman lines appear in the former, which stand out on a feeble background evidently made up of unresolved combinational frequency shifts.

R S KRISHNAN

Physics Department,
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¹ Raman, C V, *Proc Ind Acad Sci, A*, **18**, 237 (1943)
² Bhagavantam, S, *Proc Ind Acad Sci, A*, **18**, 251 (1943)
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Shear Modes in Piezo-electric Crystal Plates

WHILE investigating the diffraction patterns produced by ultrasonic waves set up in a liquid medium by piezo-electric crystal plates, we made the following observations. Besides the usual thickness longitudinal mode, diffraction patterns corresponding to thickness transverse or shear modes have been observed occasionally. We find that the appearance of such patterns is facilitated when the crystal plates are either silvered in patches only, or so prepared that there is a deviation from the normal cut. When irregular silvering is adopted, not only do the odd harmonics of the shear modes make their appearance, but also the even harmonics of all the modes begin to show up. Such results have been observed by us in differently oriented plates of quartz and tourmaline and used for determining the elastic constants corresponding to the shear modes of these crystals. Details of these investigations are being published elsewhere.

These observations mean that particular shear modes cause longitudinal strains in the crystal plates resulting in corresponding longitudinal ultrasonic waves in the liquid. The phenomenon is presumably connected with the coupling between the longitudinal and shear modes produced either by the finite size of the plate or the cut of the plate, being such that the modes themselves are inherently coupled.

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D SURYANARAYANA

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Significance of Power-Law Relations in Rheology

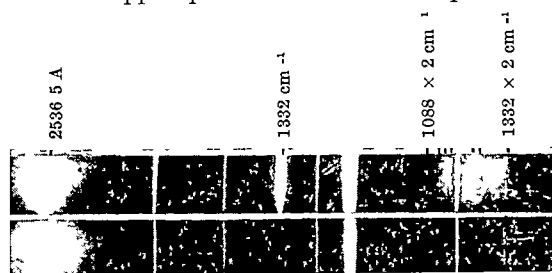
IN studying the relationship between shear stress (S), strain (σ) and time (t) in the deformations of certain bodies showing complex properties, many rheologists have effectively used Nutting's equation¹, which is now usually written

$$\psi = S\sigma^{-1/t} \dots \dots \dots (1)$$

From the point of view of physics, this has been regarded as an empirical equation and its meaning has been difficult to envisage. Exponential equations can be pictured in terms of dash-pots and springs, but power-laws lead to no such simple models.

We would suggest that a helpful way of viewing the matter, at any rate for the most usual type of experiment in which the test-piece is strained at constant stress, lies in the relationship between power-laws and fractional differentials.

Scott Blair and Coppen², acknowledging the help



above, RAMAN SPECTRUM OF DIAMOND, below, MERCURY SPECTRUM

of Dr. P. White, have discussed the significance of a fractionally differentiated form of the Nutting equation in connexion with psycho-physical experiments, and write

$$\frac{\partial^n \sigma}{\partial t^n} = \frac{\Gamma(k+1)}{\Gamma(k-n+1)} t^{k-n} \psi^{-1} S, \quad (2)$$

where $0 < n < 1$, and $\beta = 1$. This equation has also been noted by Whitehead³ to be the differential equation with fractional coefficients which represents a power-law

Scott Blair³ has proposed, as an alternative to the Nutting treatment, that complex materials be considered to show a property intermediate between shear modulus and viscosity which is, like them, independent of stress, and defined as follows

$$\chi = S - \frac{\partial m \sigma}{\partial t^m}. \quad (3)$$

We had not hitherto realized, however, that if the same exponent is used throughout in the above equations, so that $k = n = m$, equations (2) and (3)

become identical, since $\frac{\Gamma(k+1)}{\Gamma(1)}$ is a pure number

Since the property χ would seem to be more easily envisaged than are the Nutting constants, the identity of equations (2) and (3) clarifies our understanding of the rheological behaviour of complex bodies. At constant stress, $\partial^k \sigma / \partial t^k$ is constant, k being, as usual, zero for Hookean solids and unity for Newtonian fluids. The physical and psycho-physical significance of k has already been widely studied⁴.

Where $\beta \neq 0$ and S is not constant, another fractional differentiation is, of course, required, though the treatment here is not so fully understood, nor perhaps so soundly based, as that for k . We are indebted to Dr. S. Whitehead for directing our attention to the fact that the treatment here proposed must be regarded in a sense as limiting equation (1). We had already appreciated⁵ that equation (1) is only applicable in its integral form under specified conditions of stress and strain, and we are at present engaged in investigating its limitations experimentally.

Nutting's equation implies that for constant stress, for example, the rate of deformation at any time is proportional to the average rate from the start of the experiment up to that time, and further, the strain and time described as zero are arbitrary, since strain is now taken to include non-recoverable deformations and any figure may be defined as zero strain.

For materials for which $f(S, \sigma, t)$ is dependent on the history of the experiment, a direct plot of strain or time would therefore be misleading, since it would wrongly imply that a change of zero could be made in strain or time without altering $f(S, \sigma, t)$. The log-log plot does not suffer from this defect.

Maxwell⁶ appears to have foreseen something of this when he suggested that relaxation times of complex materials might well be a function of stress.

J. E. CAFFYN

G. W. SCOTT BLAIR.

National Institute for Research in Dairying,
Shimfield, Nr. Reading Nov. 21

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² Scott Blair, G. W., and Coppen, F. M. V., *Amer. J. Psychol.*, 56, 234 (1943).

³ Electrical Research Association, June 1944.

⁴ Scott Blair, G. W., *J. Sci. Instr.*, 21, 80 (1944) (in which a bibliography of papers on the use of Nutting's equation is included).

⁵ Scott Blair, G. W., and Caffyn, J. E., *J. Sci. Instr.*, 19, 90 (1942).

⁶ Maxwell, J. C., *Phil. Mag.*, 35, 129 (1868).

Freezing Point of Artificially Induced Bovine Mammary Secretions

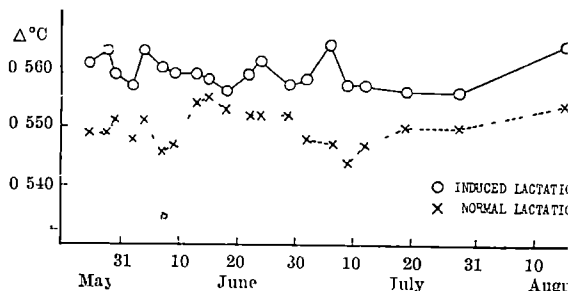
It is well known that the freezing point depression of milk is remarkably constant for cows in normal lactation¹. Folley and Malpress² have described experiments in which maiden Shorthorn heifers were treated by implantation of diethylstilboestrol or hexoestrol and they were good enough to supply me with samples of secretions from one animal in the former and two in the latter experiment. Three control animals from the same herd were also tested. Lactation in the three virgin heifers was initiated on May 21, 1942, following the administration of hormones on May 11, 1942. One heifer received during the treatment, 2.40 gm of diethylstilboestrol; the second and third, 5.01 gm and 2.54 gm of hexoestrol tablets. The heifers were milked once a day until they yielded 5 lb of milk, when they were milked twice a day. The maximum daily yield was 22 lb from one heifer and 17 lb and 14 lb from the others.

For the determination of freezing-point depression an improved model of the apparatus described by Temple³ was used which provides results in very close agreement with the Hortvet⁴ method. Following Elsdon and Stubbs⁵ suggestion, the thermometers, which were of the Hortvet type, were standardized by using three sucrose solutions. All samples were taken from individual animals and refrigerated soon after milking. Morning and evening milk was collected separately and tested within 18 hours of milking, mostly within a much shorter period. The freezing point depressions of 119 morning and 10 evening samples were determined, 59 morning and 46 evening samples being from the treated animals.

The average freezing-point depressions for each date are plotted in the accompanying graph. From this it will be seen that all the results indicate a persistently higher freezing-point depression for the secretions from the treated animals. The general mean for the maiden animals is 0.559°C , compared with the 0.550°C for that of the other cows, and this difference is highly significant. Separate evaluation of freezing-point depressions for morning and evening samples also showed significant differences. The average values were, for normal secretions, morning 0.547°C , evening 0.553°C , and for induced lactation, morning 0.558°C , evening 0.560°C .

For their normal cows, Aschaffenburg and Veinoglou⁶ have shown that during the summer the freezing point depression is persistently higher for evening than for morning milk, whereas in winter the reverse is true. Induced secretions were examined only during the summer, but likewise showed significantly higher freezing-point depressions for evening samples.

There were differences in the age and parity of the animals from which these samples were taken.



ut Aschaffenburg and Veinoglou⁶ and many others have shown that there is no correlation between these factors and the freezing-point depression of milk

Summarizing, it appears that, although only three treated and three control animals were studied, the persistently high freezing-point depression for the former constitutes a sufficiently unusual phenomenon to justify the hope that more extended experiments will be undertaken

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Accuracy of Mineral Frequency Analysis of Sediments

IN view of the important paper by Rittenhouse and Bertholf¹ on the relative efficiency of gravity and centrifuge separation as applied to sedimentary analysis, it seems desirable to present the results of certain critical examinations of sedimentary technique carried out by us during the last five years. Though originally begun merely with the intention of assessing the relative merits of certain grain-counting methods (preliminary to the computation of mineral frequencies), our work has led us to a wider study of several of the sources of error likely to operate during laboratory treatment of sediments. Basically, our method consists of applying the

various 'treatments' (for example, counting methods, washing, boiling in hydrochloric acid), and certain combinations of them, to series of replicate random analyses made from thoroughly mixed ('homogenized') sediment. Statistical manipulation of the resulting data by analysis of variance in the ordinary way then permits recognition and partition of the treatment effects. Only gravity separation (in bromoform, by Milner's method²) has so far been employed. Throughout, the specific and varietal frequencies have been expressed as number-percentages.

We utilize two counting methods. In both, the minimum acceptable number of allogenic grains per 'light' or 'heavy' subsample count is fixed at 1,000—for obvious statistical reasons. Purely authigenic mineral species are not counted. This also applies to the micas, chlorites and similar flaky minerals having densities close to the borderline between 'heavy' and 'light' (sg 2.9), for their errors of separation are found to be unsystematic, unpredictable and disproportionately large. In the first method (P S W), central transects (totalling 1,000 allogenic grains or more) are counted across each of the several slides ('heavy' or 'light') made from gravity separation in bulk. In the second (P A), '1,000-gram' subsamples representing complete separations are counted entirely. Each method has been utilized in making replicate series of number-percentage determinations (at least five per series) from certain coarse-, medium- and fine-grained sediments.

On testing the frequencies in each replicate series for homogeneity² with χ^2 , we obtained no evidence leading us to suspect that the fluctuations of specific and varietal frequency within the *coarse-grained* and *medium-grained sediments* were usually due to any factor other than random sampling ($P > 0.05$ in most cases). The sensitive additive χ^2 test (ref 4, p. 79) showed that this was also probably true of each 'coarse' replicate series as a whole ($P > 0.05$ in most cases). On the other hand, when applied to

Allogenic heavy mineral species	Coarse-grained*				Medium-grained**			
	Weighted arith mean %	$k_s^\dagger$	χ^2	P lies between	Weighted arith mean %	$k_s^\dagger$	χ^2	P lies between
Black Iron Ore + Leucovene	53.82	1.2	6.039	0.20 and 0.10	40.99	1.5	9.039	0.10 and 0.05
Zircon	25.24	1.0	4.355	0.50 and 0.30	15.70	2.2	19.709	< 0.01
Tourmaline	7.20	1.2	5.748	0.30 and 0.20	17.69	2.6	26.885	< 0.01
Rutile	6.46	0.9	3.025	0.70 and 0.50	10.74	2.1	16.959	< 0.01
Kyanite	3.58	1.2	5.574	0.30 and 0.20	1.67	1.2	6.077	0.20 and 0.10
Staurolite	2.44	1.1	4.870	0.50 and 0.30	1.80	1.3	6.292	0.20 and 0.10
Sillimanite	0.62	0.6	1.677	0.80 and 0.70	0.31	0.9	3.379	0.50 and 0.30
Sphenc	0.64††	1.1	4.438	0.50 and 0.30	0.45	1.4	8.191	0.10 and 0.05
Monazite					3.55	1.5	9.464	0.10 and 0.05
Garnet					3.49	3.8	56.817	< 0.01
Epidote					0.55	1.4	7.714	0.20 and 0.10
Brookite					0.34	0.7	1.809	0.80 and 0.70
Anatase					0.19††	1.2 \	6.035	0.20 and 0.10
Andalusite								
Topaz								
Glaucophane								
Corundum								
Zoisite	2.52	1.6	9.902	< 0.05				
$\sqrt{2(\Sigma \chi^2)}$				= + 0.52, giving P between 0.61 and 0.60	$\sqrt{2(\Sigma \chi^2)}$			
$-\sqrt{2\Sigma(c-1)}$					= + 8.87, giving $P < 10^{-8}$			
First counting method				First counting method				

* Coarse sand from Bagshot Sand (Eocene), Longlands W pit, 1 m ESE Brading station, I o W

** Medium-grained sand from base of Upper Headon Beds (Oligocene), Headon Hill, I o W

† k_s = the ratio total standard error/standard error of random sampling²

†† Pooled, because expected numbers of grains in sub-samples were less than 5 (ref 4, pp 22 and 82)

Our thanks are due to Dr J C P Miller for his time-saving observation that, when k is calculated from weighted frequencies, and c is the number of analyses per replicate series, $\chi^2 = (c - 1)k^2$

the *fine-grained sediments*, the tests led us to conclude that the variations were *not* usually attributable to random sampling alone ($P < 0.05$ for the majority of species, varieties, and replicate series). Some results for the heavy mineral suites from two of the three main sedimentary grades examined are summarized in the accompanying table. Varietal analyses have been omitted for reasons of space.

Systematic errors (investigated by analysis of variance) were found to be serious only for certain flaky minerals in the fine-grained sediments. No practical justification was obtained for the theoretical criticisms frequently levelled at the transect (and 'random field') method of counting. It is clear that, providing the specific and varietal size-differences are not excessive (a condition hydrodynamically assured for the allogenic suites of most sediments), their adverse influences upon frequency estimations obtained by the transect method are not sufficiently great to warrant consideration.

The main conclusions arising from our work may be summarized as follows. For most allogenic minerals but certain flaky species (micas, chlorites, etc.) within coarse- and medium-grained sediments, the errors of number-frequency due to normal laboratory treatment are sufficiently small to be neglected, providing that the container of the separating apparatus is large enough for adequate dispersal of the grains. For fine-grained sediments, the laboratory errors are liable to be considerable for all allogenic species. A method for estimating and manipulating the latter has been given before.²

We are thus able to offer independent confirmation of certain of the results obtained by Rittenhouse and Bertholf.

Transect errors are mainly of theoretical interest, and will be dealt with elsewhere.

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¹ *J. Sed. Petrol.*, 12, 85 (1942).

² Allen, P., *Nature*, 153, 71 (1944).

³ Milner, H. B., "Sedimentary Petrography", 3rd edit., 53, Fig. 5 (1940).

⁴ Fisher, R. A., "Statistical Methods for Research Workers", 8th edit. (1941).

Transmission by Insects of a Plant Virus Complex

STUDIES on the rosette disease of tobacco, first recorded by Wickens¹, have shown that the disease is a complex one consisting of two undescribed viruses for which the names 'vein-distorting' and 'mottle' viruses respectively have been suggested.² The vein-distorting virus cannot be transmitted mechanically but is dependent upon an aphid vector, whereas the mottle virus is easily transmitted by sap-inoculation. Investigation of the insect-relationships of these two viruses³ has revealed some interesting facts. All attempts to transmit the mottle virus by aphid vectors have failed, *unless it is accompanied in the plant by the vein-distorting virus*.

The following description of one experiment out of many will make this clear. A tobacco plant, var. White Burley, infected with the mottle virus, was colonized with the aphid *Myzus persicae* Sulz., after the requisite feeding period the aphides were removed and colonized on twelve young tobacco seedlings,

5-10 aphides per plant. All twelve plants remained healthy. The mottled tobacco plant, from which these negative attempts at transmission were made, was then infected by means of aphides with the second component, the vein-distorting virus. In due course the plant developed the rosette virus complex. This plant was then again colonized with virus-free aphides and, after the requisite feeding period, these aphides were transferred to twelve tobacco seedlings but using only one aphid per seedling as compared with 5-10 in the previous experiment. Nine out of the twelve seedlings developed the rosette disease, which of course contains the mottle virus as one of its components. Having once picked up the mottle virus together with the vein-distorting virus, the aphid retains them both for long periods and in successive transfers at twenty-four hour intervals can infect twenty consecutive plants without recourse to a fresh source of virus. Having once become infected with the virus complex the aphid in a series of transfers, sometimes transmits the mottle virus alone, sometimes the vein-distorting virus alone and sometimes the whole complex. A somewhat similar phenomenon has been recorded in the aphid transmission of two potato viruses⁴, but a clear-cut obligate relationship such as this between two viruses so unlike as the components of the rosette complex seems to be of unusual interest.

The most likely explanation of the phenomenon is a quantitative one, namely, that there is more mottle virus in a plant infected with the complex disease than in a plant containing this virus alone. But dilution tests made from the complex and from the mottle virus respectively do not appear to support this explanation.

It is possible that this phenomenon has a wider application in Nature than has been realized, and it may be discovered that other plant viruses which are apparently not insect-borne when alone can be so transmitted when in the presence of another virus.

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¹ Wickens, G. M., *Rhodes Agric. J.*, 35, 181 (1938).

² Smith, Kenneth M., *Parasit.*, in the press.

³ Smith, Kenneth M., and Lea, D. E., *Parasit.*, in the press.

⁴ Clinch, P., Loughnane, J. B., and Murphy, P. A., *Sci. Proc. Roy. Dublin Soc.*, 21, 431 (1936).

Selective Power in Virus Transmission Exhibited by an Aphid

THE selective power exhibited by insects in the transmission of different plant viruses is a subject of considerable interest since it is calculated to throw some light on the relationship between virus and insect. Such selective transmission has been studied by Hoggan¹, Kenneth Smith² and Kassanis³, while Black⁴ has shown that there are two strains of potato yellow dwarf virus, each with its specific insect vector.

So far as I am aware, however, the selection of one virus by a particular aphid species, out of a complex of two closely similar aphid- and sap-transmissible viruses, is a new phenomenon. This has been demonstrated in my experiments on the aphid transmission of viruses affecting cruciferous plants

The viruses in question were those of cabbage black ringspot (*Brassica Virus 1*) and cauliflower mosaic (*Brassica Virus 3*)

The aphides *Myzus persicae* Sulz and *Brevicoryne brassicae* Linn., when colonized on cauliflower seedlings infected with these two viruses, transmit both, but the aphid *Myzus ornatus* Laing, similarly colonized, picks out the cauliflower mosaic virus, leaving the black ringspot virus behind

A full account of this work is being published elsewhere

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Fluorine in Fish Pastes

THOUGH there is much interest at the moment in the fluorine constituent of the diet, appreciation of the benefits to be obtained from certain types of food which have recently been shown to contain fluorine is by no means new. For example, in ancient Tibet the most cherished gifts received by a new mother consisted of powdered yak bone and pigs' knuckles. In India a diet of rice and fish, from which the bones were discarded, commonly resulted in calcium deficiency, which was remedied when small whole fish were included in the diet. In Deaf Smith County, Texas, where the fluorine content of the water is 2.2–2.7 parts per million, the inhabitants are reputed to have a very low dental caries susceptibility. In a recent investigation on the Tyne-side, it has been suggested that the delayed onset of caries in a section of the population may be due to the fact that the water supply to this particular area contains 1.4 parts of fluorine per million. The Eskimos of the Pacific northwest have superb teeth and their diet includes soft fish bones which contain 250 parts per million of fluorine.

Before the War, some fish-paste manufacturers obtained their supplies from fresh fish, others from canned fish, there is reason to believe that some manufacturers now use macerated whole fish in the mix, and it was therefore thought that fish pastes might contain much available fluorine. We recently requested the Chemistry Division of the Royal Aircraft Establishment to analyse five well-known brands of fish paste, the following report was received:

Type of paste	Calcium % Ca/wt.	Phosphorus % PO ₄ /wt.	Fluorine parts/million (wt.)
1 Bloater	0.17	0.39	5.8
2 Salmon, shrimp, etc.	0.22	0.43	8.2
3 Smoked herring	0.12	0.25	3.1
4 Salmon and shrimp	0.23	0.37	8.0
5 Salmon and shrimp.	0.26	0.34	8.9

"The method employed consisted of ashing the paste at dull red heat (600°C), followed by extraction of the ash with dilute hydrochloric acid. Calcium was determined by precipitation as oxalate followed by back-titration with standard hydrochloric acid. Phosphorus was estimated by precipitation as magnesium ammonium phosphate which

was then ignited to magnesium pyrophosphate. Fluorine was determined in accordance with the method described in the *Analyst* of August 1944, page 243. (Steam distillation of the ashed paste with perchloric acid in the presence of silicates and subsequent comparison of the distillate with a standard fluoride solution, using an Alizarin Red/Thorium lake as the colour indication.)"

It has been suggested that the diet should contain 1 milligram of fluorine per day for the prevention of caries, this is provided by 2½ quarts of milk, or three grams of beef bone, or a quarter of a pound of fish paste (types 4 or 5).

We feel, then, that there are probably few people who would go to the extreme of taking daily 1½ jars of fish paste in the hope of avoiding the necessity of conservative dental treatment, and suggest that they seek a more suitable source of fluorine.

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Effect of Methionine upon Nitrogen Losses in the Urine following Severe Burns

It has been known for some time that, following fractures, there are losses of nitrogen in the urine as urea¹. Lately, in this laboratory, similar losses have been found after severe burns in animals, the loss being quite appreciable even ten days after burning², these changes also occur in patients³. The nitrogen loss in rats can be largely eliminated by increase of protein in the diet from 14 to 22 per cent⁴, this figure including some 4 per cent of yeast protein⁴, the remainder being casein. In man it has proved necessary in some patients to give up to 2,000 gm of protein per week to stem the nitrogen loss⁵.

In attempting to explain this loss, one hypothesis to be considered is that the tissue proteins are being raided by the body to provide one, or perhaps a few, amino-acids especially needed for repair of the burned area, the increased nitrogen elimination would then be due to the excretion as urea of nitrogen from the unwanted amino-acids in the raided protein molecules. We have obtained evidence in support of this hypothesis. In controlled experiments with rats, 1 per cent *D*-methionine prevented the loss after burns as effectively as the increased protein in the experiments referred to above. This improvement was not obtained with alanine or with an *ad hoc* amino-acid mixture.

These facts, supporting the hypothesis advanced, at the same time make unnecessary the view that the nitrogen losses in burns are due to toxæmia, as they can be explained upon the basis of deficiency. Now that tannic acid has been discontinued, due to the finding that it may damage the liver in human patients⁶ as well as in animals⁷, there is little evidence that thermal burns *per se* cause liver damage⁷, hence it does not seem that the effect obtained with the methionine is due to its well-known action upon the fat metabolism⁸. The reason for the call for methionine is not yet clear, nor the physiological steps involved, but the experiments, the full details of which will be presented elsewhere, suggest

that methionine might benefit patients suffering from burns, at the stage where the appetite is too poor to allow of ingestion of adequate protein. An amount of 5 gm per diem has been tolerated⁹

Our thanks are due to the Medical Research Council for grants in aid of this research and to the Ministry of Supply for synthetic methionine and other amino-acids which made the work possible, to J Jenkins for technical assistance and to colleagues in the Department for advice. The work has been carried out under the aegis of the Burns Sub-Committee of the War Wounds Committee, Medical Research Council

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Colour Phenomena in Ultra-Violet Vision

THE note by N I Pinegin¹ suggests a more detailed discussion of the relation between the threshold intensities for scotopic and photopic vision in the ultra-violet. The threshold ratio T_p/T_s is a measure of the intensity range, often misleadingly called 'photochromatic interval', in which the visual impression is free from the specific colour sensation. This intensity range is a marked function of the position of the illuminated area on the retina, the threshold ratio increasing with increasing angle from the fovea. Since Pinegin's note does not contain any data for this angle, it is difficult to draw definite conclusions from his results.

It seems, therefore, a suitable opportunity to record the results of measurements of the threshold ratio at 365 mμ for four normal observers and one observer with an aphakic eye. These measurements were made in 1938 in connexion with investigations on the photosensitivity of visual purple and scotopic vision in the ultra-violet². The threshold ratio was determined using the same observers and apparatus as described in the previous paper for the measurement of the absolute scotopic sensitivity at 365 mμ. The procedure adopted was as follows.

After 5 minutes dark adaptation, monochromatic light flashes of about 1 second duration were viewed with the parafoveal region of the retina 10° temporal or nasal for right or left eye of the observer respectively. (The illuminated retinal area was a circular patch subtending an angle of 2.6° in the normal eyes and 4.4° in the aphakic eye.) The intensity of the flashes was twice slowly decreased and increased, and the relative intensities noted

which corresponded to the disappearance and re-appearance of the 'colourless' (scotopic) visual sensation and the colour (photopic) sensation. This procedure occupied 8-11 minutes. The mean value for the threshold ratio arrived at from the observations and shown in the table correspond, therefore, to a mean dark adaptation of 9-10.5 minutes. Little variation of T_p/T_s with dark adaptation was found after the first 5 minutes.

Observer	Age	Eye	$\log_{10} (T_p/T_s)$			
GC	27	R	1.8			
CFG	34	R	2.3			
RJL	42	L	2.3			
EES	27	L	2.1			
AGG	26	L aphakic	I 2.7	II 4.7		

Assuming that Pinegin's results for the absolute photopic threshold were obtained in a comparable retinal region, we get in conjunction with the results from our earlier paper for the absolute scotopic sensitivity a value $\log_{10} T_p/T_s = 2.6$ at 365 mμ, in fair agreement with the above table. A value of $\log_{10} T_p/T_s = 2.7$ at 546 mμ derived from the same sources could be compared with the measurements of Wentworth³ which gave values of $\log_{10} T_p/T_s = 1.8$ and 2.2 at 522 and 582 mμ respectively and at a retinal position of 10° from the fovea.

The most remarkable result of our measurements is the appearance of a clearly defined second chromatic threshold in the aphakic eye. An increase of the light intensity in the region of violet sensation above the first threshold led to a point where there is a sharp transition from violet to a distinctively blue sensation. Furthermore, this transition point could be reproduced quite accurately irrespective of whether it was approached from above or below. The value of two logarithmic units derived from the table above represents, therefore, a definite quantitative measure for the intensity interval between the blue-violet point and the violet-colourless point. It seems likely that this effect is a consequence of the extremely high sensitivity of the aphakic eye in the ultra-violet, where it is found to be of the same order as in the visible part of the spectrum. The sensitivity of normal eyes was found to be about 10,000 times smaller at 365 mμ than at 546 mμ. As this difference is due to the presence in normal eyes of an absorbing substance in front of the perceptive organs of the retina rather than to a difference of the process of vision in the two spectral regions, it is to be assumed that the complex colour vision is also present in normal eyes but not clearly observable at usually available light intensities. An indication of its presence in normal eyes may be found in the widely diverging descriptions of the subjective colour of ultra-violet light, ranging from distinctive blue to distinctive violet⁴, and in the frequent observation of Goodeve (private communication) that a strong mercury arc viewed through a deep violet filter which passes only the 405 mμ line, looked quite blue.

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¹ Pinegin, N I, *Nature*, **154**, 770 (1944)

² Goodeve, C F, Lythgoe, R J, and Schneider, E E, *Proc Roy Soc, B*, **130**, 380 (1942)

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⁴ Saidman and Dufestel, *CR Acad Sci*, **182**, 1173 (1926) Saidman, J, *CR Acad Sci*, **198**, 1537 (1933) de Groot, W, *Nature*, **134**, 494 (1934) Gaydon, A G, *Proc Phys. Soc*, **50**, 714 (1938).

Colour Vision of the Fovea Centralis

MR. E. N. WILLMER¹ in his communication in *Nature* of May 11, 1944, and in his recent address to the Colour Group of the Physical Society (November 22), directed attention to the defective colour vision of the fovea centralis in the normal eye. He pointed out that the colour confusions which occur here are similar to those experienced by blue-blinds (itanopes).

It is worth recalling that fifty years ago König² came to a like conclusion from careful experiments on his own and other normal eyes. Describing his work, he wrote "I have established the complete achromatism of my fovea by setting up foveal colour matches between mixtures of 650 mμ and 75 mμ on the one hand and all intermediate spectral regions on the other. The matching field could, it is true, be held in the fovea for only a few seconds, frequently for only a fraction of a second." Despite these fixation difficulties, König was able to determine the green and red *Elementarempfindungen* for the central fovea, and to compare them with the corresponding curves for a larger matching field extending into the truly trichromatic region of the macular retina. He explained the observations in terms of his theory of the function of visual purple and visual yellow. The theory has not thrived and the experimental result just described may in consequence have attracted less attention than it deserves. Parsons³ refers to it, however.

It may be well to emphasize that partial or complete blue-blindness of the fovea centralis can be accommodated in various visual theories (König's *vn*, for example) and does not provide a crucial test of Mr Willmer's

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Parsons, J. H., "Colour Vision"

DR M. H. PIRENNE's experiment on colour vision¹ seems to be designed to test Willmer's suggestion that the rods are the end organs which are mainly responsible for the sensations of blue and violet², and he reaches the conclusion that "The rods are not necessary for colour vision"

Such a conclusion from this experiment (much of the substance of which is reported by Parsons and attributed to Gotch³) is scarcely justified. Pirenne's curve for violet light shows three 'coloured' points, two of which, those at 0.75° and at 0.34°, would, on the basis of Østerberg's data, fall on rod-containing retina. The third, if accurately focused, seems to utilize a portion of retina free from rods, but when stigmatic and other aberrations are considered, even this test area might fall partly on the rods. Thus a 10' test field used could have stimulated the rods, and therefore if one postulates, as Willmer has done, that the rods are mainly concerned in blue and violet vision, the results given are not contradictory to this suggestion.

Objects which subtend a much smaller visual angle than 10' would seem to be necessary if evidence is

to be collected on this point. One such object is used in the following experiment, which demonstrates the blue blindness of the fovea noticed by König (ref 3, p 84). A hole 2 mm in diameter was drilled in sheet metal and covered with an Ilford spectrum-violet filter which is stated to transmit only wave-lengths less than 4800 Å. This was then viewed at a distance of 10 metres with a strong source of illumination behind it. By looking directly at the violet spot and so using foveal vision, the small star-like image could be made to disappear entirely, whereas on viewing the test object with the parafoveal retina the deep violet colour could be easily seen. If the Ilford spectrum-red filter was used (stated to pass only wave-lengths greater than 6200 Å), no such disappearance with foveal and re-appearance with parafoveal vision was possible at any distance. The test object subtends an angle of about 1' at the eye in this experiment, but owing to aberrations of the optical system the area of the retina illuminated in practice would be larger than that calculated from this visual angle, it is probably not larger than the size of the rod-free area given by Østerberg.

The blue blindness of foveal vision can be explained in two ways

1 The test object disappears because its image lies wholly within the rod-free area of the retina, and thus according to Willmer's theory on receptors which are insensitive to violet light

2 At the fovea there is an increase in the amount of macular pigmentation sufficient to absorb the whole of the violet light

This latter view is commonly held, but it does not agree with anatomical data, which show that the amount of yellow macular pigment present is actually less at the fovea than it is at other parts of the central area, and it may possibly be absent altogether⁴. The absence of violet receptors in this region would explain the above result quite as well.

It might be argued that if indeed there was a violet-blind foveal area, one would see a dark spot at the centre of an evenly illuminated violet field. In fact, one would not see such an area, because one would disregard it in the same way that one disregards the shadows on the retina of the retinal vessels. Hence it appears that the rods may be necessary for colour vision and may be, as Willmer postulates, the receptors most concerned with violet vision.

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¹ Pirenne, M. H., *Nature*, 154, 741 (1944)

² Willmer, E. N., *Nature*, 151, 213 and 632 (1943)

³ Parsons, J. H., "Colour Vision", 2nd ed., 85 (Cambridge, 1924)

⁴ Polyak, "The Retina", 198 (Chicago, 1941)

MR. L. C. THOMSON says in his communication that my experiments¹ on colour vision in the dark-adapted eye do not prove that the rods are not necessary for colour vision, because in all cases the blue light of the test field might (according to Mr Thomson) have stimulated rods—which in Willmer's² theory are supposed to be mainly responsible for blue and violet vision. It must first be pointed out that my statement "The rods are not necessary for colour vision" is not a general conclusion, as it may appear to be in the quotation given by Thomson. Its context

shows that it refers to the particular conditions of the experiments. It continues "on the contrary, where they [the rods] are present in fair numbers, the colour of the violet test field vanishes"¹ This fact is not explained, or even mentioned, by Thomson. It was, however, the crux of the argument.

It is by no means certain that, as suggested by Thomson, the rods were always stimulated to some extent in the experiments mentioned. As can easily be verified, the use of a 2 mm artificial pupil reduces in a striking way the effects of aberrations of the eye in what concerns the spread of the retinal image. Since the experiments were made at threshold intensities, moreover, it is likely that only the brighter, central part of the retinal image of the field was actually able to stimulate receptors. The field, when seen, appeared as a well-defined small area. All this makes it improbable that rods were stimulated when the field was presented at an angle of 0.15° (When the light falls in an area containing a certain number of rods, as presumably happens at an angle of 0.75°, the cone threshold may still be lower than the rod threshold if the field is small and if spatial summation in the rods takes place only to a small extent.)

Even if it were proved, however, that the rods were always stimulated in the experiments discussed here (using the dark-adapted eye), the fact remains that the presence of many rods, as observed in parafoveal vision, is highly *detrimental* to blue or violet vision. In brief, therefore, when an area containing many rods is stimulated with violet light, no colour is seen, and, in some of the cases where colour is seen, it is at least doubtful whether any rods are stimulated. These observations seem incompatible with Thomson's suggestion that the reason why (in my experiments) the light appeared coloured by foveal vision is that it spread on to parts of the retina which contain rods (The mechanisms active under conditions other than dark adaptation are not discussed either in the original paper or here.)

The bibliography given in my paper makes it clear that there was no claim to originality in the type of experiments described. They were made largely because Wentworth² in her extensive investigation (which is more recent than Gotch's⁴ and more like my experiments) had found in the central area of the retina an achromatic threshold which is lower than the chromatic threshold. This was not found in my experiments. Differences in the conditions used account in a general way for the different results obtained.

Thomson reports an experiment from which he seems to conclude that the rod-free area is completely insensitive to violet light, and which he gives as a demonstration of the 'blue blindness' of the fovea noticed by König⁵. What König meant by this 'blue blindness' is a certain type of dichromatism "which, however", in König's words⁶, "by no means implies complete insensitivity to light of short wave-length". This is obvious, for König states⁷ that he was able to match all spectral colours with mixtures of 650 mμ and 475 mμ in the fovea, which implies that the latter wave-length is able to stimulate the fovea—and that the stimulation it produces can be confined to the receptors contained in this area. It is therefore possible that, if the violet light used by Thomson was not seen by foveal vision, it was because the light was not sufficiently bright.

According to König's data, the centre of the fovea is dichromatic. According to Young's theory, it is therefore a two-receptor system. But it is not clear

whether the more peripheral parts of the rod-free area, in which the cones are somewhat different anatomically from those of the "bouquet central" are dichromatic or trichromatic. It seems that this discussion cannot be carried much further before this point is settled.

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¹ Pirenne, M. H., *Nature*, 154, 741 (1944).

² Willmer, E. N., *Nature*, 151, 213 and 632 (1943), 153, 774 (1944).

³ Wentworth, H. A., *Psychological Monographs*, 40 (1930).

⁴ Gotch (1912) quoted in Parsons, Sir J. H., "An Introduction to the Study of Colour Vision" (Cambridge, 2nd ed., 1924).

⁵ König, A., "Gesammelte Abhandlungen zur Physiologischen Optik" (Leipzig, 1903).

⁶ König, A., *loc. cit.* 396.

⁷ König, A., *loc. cit.* 356.

⁸ Osterberg, G., *Acta Ophthalm.*, Suppl. 6 (1935).

Persistence of Vision

PERSISTENCE of vision is the basis of the cinematograph, but there is no persistence of vision when the eye is moved in ordinary circumstances. If there were, reading would be a difficult and slow process. This is explained by the double function of the ocular muscles, the decomposed photochemical product being pressed in the direction in which the eye moves beyond the fixation point.

There is another form of persistence of vision, namely, that of positive after-images. If a strip of white paper 3 in. × ¼ in. be placed on a sheet of black cardboard, in a good light, and viewed for the shortest possible time, and the eyes then closed and covered with the hands, a clear-cut positive after-image of the paper will be seen, which will gradually fade away without becoming negative. If the eyes, being closed and the positive after-image clearly visible, are moved to the right, the whole after-image will appear to move to the right past the fixation point. It will also bulge towards the right. These observations can be explained on the view that the photochemical stimulus in vision is in liquid form, and that the cones are stimulated indirectly by these products, and not by the direct action of light.

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Classification and Nomenclature of Animal Behaviour

MODERN work on the simpler forms of behaviour has gained much from the classification of reactions into different types. Its main achievement has been the separation of kineses from taxes. Fraenkel and Gunn have brought order into the subject with the book, "The Orientation of Animals. Kineses, Taxes and Compass Reactions" (1940). The following criticism is offered in the belief that they have provided a valuable point of departure for future work.

The authors argue (p. 22) that "When activity results from high intensity or concentration of the stimulus, it should be called *high kineses*, and when it results from low intensity or concentration, it should be called *low kineses*". There is a weakness

here that the authors do not deny. If a kinesis is called 'high', the obvious implication is that it is a stronger reaction than one that is 'low'. It requires a mental effort to recall that 'high' is used quite differently here, to indicate the *sense* or *'sign'* of the reaction with reference to the stimulus. The authors fear that even greater confusion would arise if high kineses were called positive kineses. A positive photo-kinesis, for example, can lead to aggregation in darkness, but this has been called photo-negative behaviour in the past. The argument raises a wider issue than mere nomenclature.

Besides clearing up confusion among reactions, recent work has helped to clear up another source of past confusion. It has sharpened the distinction between the two planes on which behaviour may be studied. On one plane are the reactions of single animals to single stimuli, the *units* of behaviour. On a higher plane are the spatial re-distributions and average activity changes that appear when a mass of animals is subjected to a whole system of stimuli. It follows that the laws governing the units of behaviour must underlie, but cannot be the same as, the laws governing organized systems of those units.

Fraenkel and Gunn do not make that qualitative distinction. For example, they describe aggregation in temperature gradients and average activity changes under continuously changing temperature. They show how such behaviour has been misinterpreted in the past by treating it as equivalent to simple reactions or metabolic effects. Having gone so far, they return to the analysis of reactions, as if mass behaviour comprised no more than a sum of reactions. They do not emphasize that mass behaviour has its own laws requiring separate study. Instead, they argue that a term like 'photo-negative' should be applicable to kineses, taxes and aggregations alike. This confuses different reactions; and more, it confuses phenomena on two different planes.

The following usage is suggested as more logical. Terms like 'photo-negative' should be confined to the description of taxes. This removes any justification for the awkward expression 'high kinesis'. The *sense* or *'sign'* of reactions should be indicated uniformly, using positive and negative for both kineses and taxes. Thus, in the case of a positive kinesis, strengthening the stimulus leads to greater activity, and weakening it leads to weaker activity. In a gradient of stimulation intensity, aggregation would occur where the stimulus was *weakest*. In the case of a positive taxis, of course, aggregation occurs where the stimulus is strongest. In a negative kinesis, strengthening the stimulus leads to weaker activity, and weakening it to greater activity. In a gradient, aggregation will be where the stimulus is *strongest*. In a negative taxis, aggregation occurs where the stimulus is *weakest*. This usage should serve to sharpen the distinctions drawn above and to help to consolidate the gains of recent years.

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When writing the book referred to by Dr Kennedy, we were frequently faced with the alternatives of inventing new technical terms (which are often resented by the people who have to learn and use them) and of using common words in newly defined

ways (which causes trouble because it is difficult to exclude from one's mind some of the common implications of the words). If Dr Kennedy, who has studied insect activity and aggregation in the field as much as anyone, has to make an excessive mental effort with 'low' and 'high' kineses, then the generality of zoologists must find them very troublesome indeed. The advantage of the broad use of 'photo-negative' is that it can be applied to a particular reaction before one knows which type of behaviour is responsible for aggregation in the dark. 'Positive' photo-kinesis can lead to photo-negative behaviour. If this awkwardness of signs is generally thought to be preferable to the ambiguity to which Dr Kennedy directs attention, then let us use his modification of the system of terms.

Dr Fraenkel and I did not write much about the 'plane of integrated behaviour, because we set out to deal with the elements of behaviour, apart from learning in Arthropods, reviewed by Thorpe¹. I doubt if enough is yet known to justify a treatise on invertebrate behaviour in this plane. We were, however, able to deal with some aggregations in which animals react to components of a situation other than each other.

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¹ Thorpe, W H, *Brit J Psychol*, 33, 220, 34, 20 (1943)

Moulting Fluid of Woodlice

It is well known that in insects during the process of moulting or ecdysis there is a thin plasma or moulting fluid. "When the epidermal cells separate from the old cuticle and begin to secrete the new, the space between the two cuticles is occupied by a thin plasma. In the later stages of moulting this space is filled by an abundant fluid, the moulting or ecdysial fluid, first clearly demonstrated by Newport. There can be little doubt that much of this fluid, which extends also throughout the tracheal system, arises by exudation from the epidermal cells, indeed, this has sometimes been its sole source. But the epidermis of the majority of insects contains numerous glands which become active only at the time of moulting and certainly contribute to the secretion of the fluid."¹

In the literature on moulting of the woodlice, I have failed to find in the writings of Schöbl, Friedrich, Leichmann, Němec, Schönlchen, Herold and others any reference to such a fluid in these isopods. Recently, I have had occasion to mount small pieces of the exuviae recently cast by *Armadillidium vulgare* (Latr.), and I noticed that they seemed to adhere to the glass slide; on being removed a faint film was noticeable where each fragment had been. In longitudinal sections of *Porcellio dilatatus* Brandt, the epidermal cells show numerous glandular ones, which, I suggest, may give rise to this plasma. Moreover, in the space between the cuticle and the epidermis there is a uniform, thin streak of non-cellular matter. This was present in all the sections. Finally, exuviae, in alcohol, show a thin glistening substance on their inner side.

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¹ Wigglesworth, "Principles of Insect Physiology" 25 (1939)

RESEARCH ITEMS

Corpora Lutea in Elasmobranchs

THE fact that in an elasmobranch, *Myliobatis bovina*, after ovulation the follicle is transformed into a glandular organ was first reported by Giacomini in 1896. The formation and structure of this gland in another batoid, *Rhinobatus granulatus*, investigated more fully and by more modern methods, have been recorded by Miss Mary Samuel (*Proc Indian Acad Sci*, 18, 1943). This gland, a corpus luteum, is formed after the discharge of the ovum in a manner homologous with that in mammals. The luteal cells are derived from the follicular epithelium and invading cells of the theca interna, while intrusions of the theca externa accompanied by blood vessels without either the hypertrophy or luteinization of its cells provides a framework. It is noted that the fully formed corpus closely resembles that of a mammal, but it also has its own distinctive characteristics. In the mammal the corpus luteum is associated with the maintenance of pregnancy, a typical mammalian function, and its presence in an active state appears to suppress ovulation. Miss Samuel, however, records that each ovary in *Rhinobatus* may contain twenty corpora lutea in all stages of development, from newly formed to fully active glands and also maturing follicles.

Primitive Fishes

THE late Dr Bashford Dean left an extensive and valuable collection of notes and drawings on various groups of the archaic fishes. The American Museum of Natural History very wisely decided to have this material worked up in the form of a Bashford Dean Memorial Volume, which they entrusted to the able editorship of Dr. E. W. Gudger. The last two articles of this work are just to hand, and the extent of the whole work has rendered it necessary to bind the volume in two parts. Article 7, by E. W. Gudger, is on the breeding habits, reproductive organs and external embryonic development of *Chlamydoselachius* and is illustrated by six plates and 33 text-figures. Article 8, by B. G. Smith, is on the natural history of the heterodontid sharks and the external development of *Heterodontus japonicus* and is illustrated by seven plates and 69 text-figures. The plentiful material for both these memoirs was obtained in Japan by Bashford Dean, and both contain valuable contributions to our knowledge of these rather rare, primitive sharks. The two authors and the American Museum are to be congratulated on rescuing this work from oblivion, and it is a pleasure, in these times of stress, to handle publications that are presented in such a splendid form.

Serious Fungoid Disease of British Mackerel

NORA G. SPROSTON describes the occurrence and life-history of *Ichthyosporidium Hoferi* in mackerel mainly landed at the Plymouth Laboratory (*J Mar Biol Assoc*, 26, 72, 1944). The presence of the fungus, which has been recorded from trout in Germany, from herring in the Gulf of Maine, and which probably occurs in several British marine fishes, is indicated in the mackerel by necrosis of the viscera with the production of a thick brown fluid, but there are no external signs of lesion or colour change. In the four years 1940-43, when samples were examined, the incidence of the disease continued to be high, and since it renders the fish inedible, the suggestion is made that mackerel should

be split and gutted and at once packed in dry crushed ice. The opening of the fish would at once reveal badly infected individuals, which should be discarded. The main part of the paper describes the profuse forms developed by *I. Hoferi* in the mackerel—chlamydospores, conidia, hyphal bodies, branched conidiophores, clavate sporangia, hyphal fusions, spores produced by hyphal fusions—several of which are described for the first time. There is no need for an intermediate host, and infection in the sea may be spread by living individuals or from dead fish or discarded offal of diseased individuals. Within an individual an infection spreads throughout the viscera by way of the blood stream, kidney and spleen, eventually breaking down and blood vessels becoming toughened by the hyphae and nodules of the parasite. Only in very advanced cases do the body muscles degenerate.

Management of Honey-bee Colonies

CIRCULAR No. 702 of the U.S. Department of Agriculture by C. L. Farrar deals with the above subject in the northern States. It is pointed out that the trend in bee-keeping practice in recent years has been to increase the number of hives in an apiary with less attention to individual colonies. As a consequence, most commercial apiaries are reporting average yields of about one third of those obtained from maximum-producing colonies. The most effective way to lower production costs is through increased colony yields. This Circular gives the necessary information on practices that will give the best returns from each colony. In the northern States the equivalent of not less than two ten-frame hive bodies should be used to house the colony during the winter, and not less than five during the active season. The colony to be overwintered should have a gross weight of not less than 130 lb. and consist of a laying queen along with 8-10 lb. of bees that emerged after August 20. The hive should contain not less than 40 lb. of honey in the upper body with pollen and some empty cells in the centre, and 20-30 lb. of honey and as much pollen as conditions allow in the lower body. The development of colonies adequately provisioned with pollen can be increased by feeding pollen supplemented with 75 per cent of soy bean flour. The bee-keeper should be familiar with the sources of pollen and nectar in his locality. During the active season the object is to build maximum populations for the honey flow and maintain them throughout the season. The most populous colonies produce not only the most honey per hive but also the most honey per bee. Brood-rearing is the basis of colony development and the maintenance of maximum populations during the flow.

Yew Scale

G. FOX WILSON has described the life-history and control of the yew scale, *Lecanum cornu-crudum* (*J Roy Hort Soc*, 69, Pt 8, Aug 1944). The pest is at present distributed in the south of England. Attacks are mainly recognized by the presence of black honey dew on the shoots—black because of the presence of sooty mould fungi. Eggs of the pest are laid towards the end of June and hatch during the summer. Overwintering is usually accomplished as second-stage larvae. Dispersal of the insects may be effected by birds, wasps and bluebottles, in addition to the distribution of infected plants. Control has been accomplished by spraying with a nicotine and white oil emulsion in autumn and spring.

Genetics of Cultivated Species of Cucurbitaceae

C F POOLE (*J Hered*, 35, 122, 1944) summarizes the genetics of the water melon, cucumber and musk melon since 1937, when a summary was published in the Year Book of the U S Department of Agriculture. Upwards of twenty-five different qualitative characters and thirteen genes associated with fruit weight have been isolated in the water melon, and seventeen characters in the cucumber are now determined to be controlled by genes. Resistance to disease, sex determination and chlorosis are also partly analysed in respect of their inheritance. Of particular interest is the evidence that transmission of a mottling of leaves and fruit is by means of plastids and that an abnormal plastid may be carried by the pollen tube. Linkage relationships and gene interactions are also reported.

Barley-Rye Hybrids

R A Brink, D C Cooper and L E Ausherman (*J Hered*, 35, 67, 1944) report the results of some interesting experiments in wide hybridization. The hybrid embryos of *Hordeum jubatum* with *Secale cereale* cease growth at 6-13 days after fertilization if they are left on the mother plant. If the embryos are dissected and grown in artificial media, they continue growth, 33 out of 81 such embryos developed in an undifferentiated manner, but one developed normally and was grown to maturity. These experiments confirm the view that infertility frequently arises from the non-functioning of the hybrid endosperm and not from the hybrid zygotes. The cytological examination of this unique hybrid indicates little homology between the chromosomes and the parents, but the characters of the hybrid were intermediate between those of the parents.

Statistics of Field Experiments

E A. Cornish (*Bull* 175), and I E Phipps, A T Pugsley, S R Hockley and E A Cornish (*Bull* 176, *Aust Coun Sci and Indus. Research*) have extended the statistical analysis of Fisher and Yates to lattice squares and cubic lattice designs, and suggest methods for use where the data are incomplete.

Synthetic Morphine Substitutes

EXPERIENCE with synthetic oestrogens has proved useful in the search for synthetic substitutes for morphine. The naturally occurring oestrogens all have the same basic ring structure, they differ only in the position of double bonds and polar groups. So the discovery of synthetic oestrogens such as stilboestrol which did not possess this ring structure but which nevertheless were chemically related, though somewhat distantly, to the natural oestrogens, was somewhat surprising and opened up new fields of investigation. E C Dodds, W Lawson and P C. Williams (*Proc Roy Soc*, B, 132, 119, 1944), realizing that morphine has a phenanthrene ring structure somewhat similar to that of oestrone, have synthesized a number of analogues which bear roughly the same chemical relationship to morphine as does stilboestrol to oestrone, and have shown that some of these analogues have morphine-like properties. The synthetic substances investigated were diphenyl-ethylamine and seventeen other related compounds. From the clinical point of view the most promising one discovered was β -hydroxy- α -diphenyl ethylamine, which, in 4-hourly doses of 200-400 mgm by mouth, relieved pain as effectively as morphine. It remains to be seen whether such substances are habit-forming.

Possibility of Aurora in a Comet's Tail

JULIE M VINTER-HANSEN has written in the *Publications of the Astronomical Society of the Pacific* on some interesting comet observations, and a short account of the article is given in *Sky and Telescope* of June. On March 29, 1943, Arend, at Uccle, noticed a nebulous object of 13th magnitude with a nucleus, and the object was close to Comet Whipple (1942g). Subsequent measurements showed that its position must have coincided with that of the comet on March 28.5. Dr Brunner-Hagger, at Zurich, had photographs of the comet on nearby dates, and these confirmed the view that the nebulous object had split off from the comet on March 28.5. On March 27 a fine aurora was seen, and from the time which elapsed between the appearance of the aurora and formation of the cometary object, it was deduced that the solar corpuscles, which are responsible for the auroras, travelled at the rate of one astronomical unit in about 30 hours. It is known from other evidence that this is near their speed, and the presumption that corpuscles shot off from the sun were responsible for disintegrating a portion of the comet's tail is strong. Other photographs of the comet showing similar spots were available for the period February 28-March 4, and solar eruptions had occurred during February 26-28, similar velocities were found for the corpuscles during this period. The view advocated may throw some light on the erratic behaviour of some comets in their sudden variations in magnitude.

Problem of U Cephei

It has long been known that insuperable discrepancies exist between the orbit of the eclipsing binary U Cephei determined from its light curve and the orbit found spectroscopically from its velocity curve, if both curves are interpreted in the standard way. O Struve now gives the results of a new determination of the velocity curve made with the 82-in McDonald reflector (*Astrophys J*, 99, 222, 1944). It is confirmed that, unlike the light curve, the velocity curve is distinctly unsymmetrical, by an amount which no permissible adjustment of the elements can remove. Struve tentatively suggests that this asymmetry may be produced by absorption in a stream of gas which starts from the B8 star and passes along the following side of the G2 star, to return toward the B8 star along the preceding side of the G2 star. Superposed lines of H and Ca II which appear in the partial phases seem to need the postulation of just such a stream. The following paper (*ibid*, p 239) by Kopal, however, points out that several eclipsing binaries besides U Cephei have conflicting spectroscopic and photometric orbits. *Ad hoc* interpretations of each are obviously undesirable. A more general explanation is needed which will attribute the distortion of the velocity curve to some peculiar distribution and motion of matter in the outer envelopes of the stars where the density is so low that the distribution of mass remains unaffected and no dynamical perturbations are produced. So long as the matter remains in doubt, the conventional spectroscopic elements should be regarded as parameters which do not readily admit of dynamical interpretation. It is disturbing to realize that ordinary (that is, non-eclipsing) spectroscopic binaries may have their orbital elements vitiated in the same way without any indication that they are so vitiated.

ANTIBACTERIAL ACTIVITY OF AMCEBÆ

THOSE who have followed the development of research on penicillin and other substances which inhibit the multiplication of micro-organisms will be familiar with Sir Alexander Fleming's discovery (*Brit J Exp Path*, 10, 226, 1929), that staphylococci cultured on a plate culture failed to develop around an accidental contamination with the mould *Penicillium notatum* and were undergoing lysis, and that culture fluid taken from a culture of *P. notatum* would, even when it was diluted 500–800 times, completely inhibit the growth of the staphylococci. This work, together with other work on penicillin and on various antibacterial substances derived from bacteria and moulds (for example, pyocyanine, gramicidin, actinomycin, aspergillie acid, helvolic acid, etc.), has been summarized in the *British Medical Bulletin* (2, No. 1, 1944) and elsewhere. In bacterial cultures in which these antibacterial substances are present, areas in which the bacteria fail to develop appear, which are sometimes called 'clearance areas'. Protozoologists have been aware for many years that certain amoebæ ingest readily certain kinds of bacteria, yeasts and similar organisms, and that they can, under appropriate cultural conditions, produce in bacterial cultures 'clearance areas' somewhat similar to those produced by the antibacterial products of moulds and bacteria. The two phenomena are, however, quite distinct. While the amoebæ clear parts of the cultures by actively ingesting the bacteria, the antibacterial products of moulds and bacteria clear them by inhibition of the bacterial growth, or even by lysis of the bacteria.

The clearance of certain areas of bacterial cultures by the active ingestion of the bacteria by an amoeba has been studied by Sir Aldo Castellani (*J Trop Med and Hyg*, 33, 160, 188, 221, 237, 1930, and 34, 83, 1931). Castellani first recorded his study of the active ingestion of the pink yeast, *Cryptococcus parvovirens* (Cast.), by an amoeba which was named *Hartmannella castellani* by M. Douglas (*J Trop Med and Hyg*, 33, 258, 1930). Castellani found that pure cultures of this amoeba could be obtained by growing it on glucose-agar smeared with the dead yeast. He also found that, when amoebæ were inoculated on to a growth of certain bacteria, after a few days a zone of clearing of the culture appeared which radiated from the point of inoculation of the amoeba. Such zones of clearing appeared in cultures of *B. typhosus*, *B. paratyphosus* A and B, *B. dysenteriae* Shiga and Flexner Y, some strains of *Vibrio paracholerae* and *B. pestis*, but not on cultures of *B. proteus*, *B. pyocyaneus*, *B. morgani*, *Brucella melitensis*, some strains of *Vibrio cholerae* and all strains of *Staphylococcus* that were tried. The amoebæ sometimes cleared bacteria (for example, *B. coli*), while at other times they did not. Douglas (*loc cit*) confirmed these results in the main.

C. E. van Rooyen (*J Trop Med and Hyg*, 35, 118 and 259; 1932) studied further this activity of *H. castellani*. He found that the clearing of the yeast and bacteria by the amoeba is due to ingestion of these organisms, and not to a diffusible lysin produced by the amoebæ or to a change in the pH of the culture, nor is the action of the amoebæ related to the action of bacteriophage. The rate of destruction of the bacterial culture is proportional to the thickness of

the bacterial growth. Van Rooyen confirmed Castellani's discovery that the amoeba eats certain bacteria only and will not eat others. He gives a list of about fifty micro-organisms which he subjected to the action of the amoeba, most of which are important pathogenic organisms affecting man and domestic animals. The amoebæ were able to destroy, after four days of aerobic incubation at 26–30°C, *B. typhosus*, *B. coli*, *V. cholerae*, *V. paracholerae*, *B. dysenteriae* Shiga, *B. pullorum*, *B. suis*, *B. pertussis*, *D. crassus*, *Micrococcus catarrhalis*, *Gonococcus* and *Meningococcus*. To a lesser degree they devoured *B. ceritrycke*, *B. suis*, *Streptococcus hemolyticus*, *B. subtilis* and some strains of *Pneumococcus Type II*. The following were not affected by the amoeba: *V. cholerae*, *B. morgani*, *B. faecalis alkaligenes*, *B. dysenteriae* Flexner, *Staphylococcus*, *Pneumococcus Type III*, *B. hoffmanni*, *B. xerosis*, *B. pseudotuberculosis ovis* (Preis), *B. anthracis*, *B. mycoides*, *B. mesentericus*, *B. abortus* (Bang), *B. melitensis*, *B. tuberculosis* (human, bovine, porcine and fish strains and R and S variants of the same), *B. leprae* (Brinkenhoff) and *B. salmonicida*.

Staphylococcus aureus was used to investigate why the amoeba did not eat certain organisms. It was found that substances produced by the staphylococci inhibited the growth and multiplication of the amoebæ. Cultures of *S. aureus* killed and washed in saline were readily eaten by the amoeba. The amoeba also readily ate killed and washed cultures of the following other organisms which they did not eat when they were alive: *B. proteus* X 19, *B. morgani* No 1, *B. pyocyaneus*, *B. anthracis*, *B. anthracoides*, *B. leprae* (Brinkenhoff) and other organisms. The amoeba ate mixed cultures provided that these contained either only susceptible bacteria or resistant ones rendered susceptible by killing and washing. The age of the bacterial culture did not make any difference to the ingestion of them by the amoeba. The amoeba is a strict aerobe and cannot multiply in anaerobic cultures. It will be noted that the bacteria which the amoeba will or will not eat do not fall within the Gram-positive and Gram-negative classifications.

Filtrates of saline washings derived from bacteria which the amoebæ will not eat were unable to inhibit the growth and multiplication of the amoebæ, they did this only when they were combined with the living bacteria and were being produced by them. In certain circumstances the appearances produced by the amoebæ in cultures of bacteria which they will eat resemble closely those produced by bacteriophage action and may be indistinguishable from those of bacteriophage actions except by examination under the low-power microscope. The amoeba is extremely resistant to emetine hydrochloride for long periods of time, and prolonged exposure (2 hr. at 75 cm. distance) to X-rays does not kill it.

It seems likely that further work with this species of amoeba, and with other species also, would increase the biological interest of these results. It might throw light on the metabolism of amoebæ in general and, when we remember that the phagocyte is an amoeba actively engaged in ingesting and destroying bacteria which are causing disease, the effects of bacterial products on amoebæ in bacterial cultures are perhaps worth further study. It may be argued that studies of a free-living amoeba in the presence of pathogenic and other bacteria in artificial cultures will not be applicable to the phagocyte confronted with pathogenic bacteria in the body, but this remains to be proved. At any rate, the work of Castellani

d van Rooyen provides the basis for studies of this kind. While we have, in penicillin and allied substances, instances of the action of metabolic products on an organism on bacteria, we have, in the work recorded, an instance of the reverse process—the action of bacterial metabolic products on an amoeba physiologically equivalent to the phagocyte, which is not, fortunately for us, affected by penicillin. The work of Castellani and van Rooyen brings us, in fact, nearer to the work on the opsonins and similar substances—work which aimed at rendering the invading bacteria more palatable to the amoebic phagocyte, at any rate aimed at helping the ingestion of these bacteria by the phagocyte. It is possible that the work done with *H. Castellani* might be best developed with this idea as its basis.

G. LAPAGE.

AGRICULTURAL SAMPLE SURVEYS

THE need for adequate statistics relating to our agricultural resources and requirements must have become obvious to all during the last few years, and the urgency of war problems has served to direct attention to the inadequacy of peace-time data and so to the methods of rapidly filling the deficiencies. Complete and reliable censuses are often impracticable and always make great demands on both time and skilled labour. Where the need is more for a quick and reasonably accurate estimate of crop acreage, yield, or whatever it may be, sample surveys will generally offer a better method of obtaining the data. These set out to arrive at an estimate of the whole from the collection of a limited sample of representative parts. The dangers of such an approach are as great as the advantages, and only by conducting sample surveys along sound statistical lines can biased or distorted estimates be avoided and a measure of the reliability of the estimate be secured.

The need for information of the kind given by sample surveys is, of course, confined neither to Great Britain nor to war-time. In 1937 a statutory body called the Indian Central Jute Committee was constituted, as one of its first tasks, a five-year scheme for obtaining improved estimates of the area under jute in Bengal. After some hesitation it was decided to use the sample survey method, the earlier years being devoted to small exploratory surveys, with a complete survey of about 60,000 square miles in 1941. It was laid down that the final estimate of area under jute should have a margin of error not exceeding 5 per cent, that it should be ready early in the jute season and that the cost should not be excessive. P. C. Mahalanobis, who was statistical adviser to the scheme, has now published an account of the methods, both organizational and statistical, by means of which the task was successfully accomplished. The final estimate was within 2.8 per cent of an independent official estimate based on census data, it was ready a week or so before the latest useful date, it cost only about £8,500 as against £110,000 for a complete census. In view of this the Jute Census Committee recommended the adoption of sample surveying to the Indian Government.

Mahalanobis' paper ("On Large-scale Sample Surveys", *Phil. Trans. Roy. Soc., B*, 231, 329-451) is divided into three parts. Part 1 describes the way in which the problem arose, outlines the method of approach and discusses production and mapping

surveys in addition to those concerning acreage. Part 2 is a mathematical treatment of the statistical theory of various methods of sample surveying. The concepts and principles are dealt with mainly in the abstract, but the results of model sampling experiments are also used. Part 3 concerns the application of this theory to crop area estimation, especially the jute survey of Bengal. The experimental results are summarized and numerical examples worked out.

The fields under jute in Bengal vary much in size, and furthermore any field may be only partly devoted to this crop. It was therefore decided to take as the sampling unit areas, termed grids, of a definite size, like four or twenty acres. The proportion of the land given to jute in each grid was ascertained, and by combining these proportions from all the grids, which were randomly located over the jute-growing area, an estimate of the jute acreage was obtained. Both the precision and the cost of this estimate depend on the area of each grid and the number of grids (that is, density per square mile) surveyed. Now for any given cost, the larger each grid is, the smaller is the density that can be used. The problem is then to adjust grid size, and with it density, so as to maximize the precision of the final estimate. The alternative procedure, which though discussed was not used for the jute survey, is to adjust grid size and number to minimize the cost for a given level of precision.

Two functions, relating cost and precision (variance) to grid size and number, were set up. The constants which they contained were estimated empirically from the data of the early exploratory surveys and by their aid the final survey was planned. The cost function was found to involve consideration of time necessary for enumerating the jute areas within each grid (which depends on grid size but not on density), of time necessary for journeying from grid to grid (which depends on density but not size), of miscellaneous time (independent of both size and density) and of time needed in the statistical laboratory. The precision, or variance, function was found to involve a parameter which took into account the correlation of cropping on adjacent fields. It was also shown that precision varied with proportion of land under jute in the grid, so that the adjustment of grid size and density best for one proportion would not be best for another. For this reason the area to be surveyed finally was divided into zones of more or less homogeneous proportions of jute land, and the best grid sizes and densities found for each zone separately.

Linked pairs of sub-samples, at constant distances apart but randomly orientated, were used to give the standard error of the final estimate. These were always surveyed by different groups of enumerators and at different times, so as to prevent collusion.

The laboratory methods of organizing the survey and randomizing the grids are described in detail, as are the kinds of errors arising from untrained and even dishonest enumerational labour. The means used to adjust the work to the very varied speeds of the enumerators are also mentioned. In the discussion of the planning of sample surveys it is emphasized that surveys of the kind undertaken are progressive. Each one adds to the information relating to the cost and precision functions and their changes with zone and time. So each enables a better survey to be planned for the next occasion. Finally, a detailed account of the work of others on survey sampling is appended.

IDENTIFICATION OF TIMBERS

TWO leaflets have recently been issued under the auspices of the Department of Scientific and Industrial Research by the Forest Products Research Laboratory, Princes Risborough. No. 34 on "The Identification of Timbers", and No. 37 on "Selecting Ash by Inspection" (H.M. Stationery Office, London, 1944). Leaflet No. 34 is intended to be a rough-and-ready guide to the identification of timbers. Its aim is the temporary one of taking the place of more elaborate text-books and official publications at present practically unobtainable. As is well known, owing to the demands of the War, a number of new or at least unfamiliar timbers are being used in Great Britain, and it is at times difficult for those wishing to do so to identify timbers the use of which is permitted by official specifications. General appearance, colour, texture, weight and smell, etc., are useful aids to the *cognoscenti*, but more reliable tests are based on the characteristic structural features remaining unaltered under conditions which may entirely change the external appearance of the timber. The object of the leaflet is to describe and illustrate the principal structural features of wood and to explain how they can be used in identifying timbers in the factory or office with the minimum of apparatus and little or no previous experience.

The text first describes the type of sample required and its method of preparation for examination, the sample being of a size convenient for handling. Details are then given of the structure of wood, heartwood and sapwood, softwoods (conifers) and hardwoods, structural features of softwoods and the same of the hardwoods. Two tables descriptive of the chief features of certain species are given, one for softwoods (larch, Scots pine, Douglas, western hemlock, spruce, noble fir, western red cedar and Parana pine) and the other for hardwoods (oak, sweet chestnut, ash, elm, beech, birch and sycamore). Two plates show photographs of cross-sections (magnified $\times 10$) of some of the species mentioned above.

Leaflet No. 37 deals with ash. The importance of ash depends largely on its mechanical properties, notably its toughness, high resistance to shock and the readiness with which it can be shaped by steam and bending. These properties are subject to considerable variation, and it is of importance to users that they should be able to judge the quality of the timber whether in the standing tree or in the conversion thereof. Mechanical testing has various inherent and obvious drawbacks, and in any event involves standardized equipment and the waste of a considerable proportion of the timber. It is therefore usually necessary to fall back on visual methods of inspection and other simple tests.

The investigations dealt with in the leaflet are made on English ash (*Fraxinus excelsior*), but generally they cover other kinds of ash commonly imported into the United Kingdom, the *Fraxinus excelsior* of Continental Europe and the American ash (various species of *Fraxinus*). Shippers usually allude to American ash as 'tough ash' or 'cabinet ash'. The better grades of the former are suitable, or at any rate are used, for many of the same purposes as well-grown English ash, and are widely used in normal times by the automobile and agricultural implement industries, most of the good ash in Britain having been hunted down and felled during the War of 1914-18.

The leaflet discusses this matter of selection of ash

by inspection under the headings of factors affecting the quality of the timber, structure as an indicator of quality, density, selection of standing timber a winter- and summer-felled timber. As regards selection, trees with a good length of straight bole, clear of side-branches and with a well-developed healthy crown at least one half the height of the tree should be chosen. Such trees are likely to be found in fairly open woodland and are preferable to those grown in crowded woods. The prejudice against summer-felled timbers, the writer says, is mainly due to the fact that weather conditions in summer favour the occurrence of splits and checks owing to rapid drying. Provided that the logs can be taken to some spot where they can be stored in sheltered conditions, there is no need to discriminate between spring- or summer-felled timber.

AMERICAN INDIAN STUDIES

BULLETIN 136 of the Bureau of American Ethnology (Smithsonian Institution) consists of a further series of six anthropological papers dealing with the American Indian and allied subjects.

Miss Frances Densmore contributes two more papers to her long series on the music of the American Indian. The first deals with the Indians of British Columbia, and is noteworthy as being her first work in Canada. Unlike most of her earlier papers, this deals with many tribes, being the product of a visit to a hopping centre where Indians from wide separated localities were at work. The music of the Choctaw Indians of Mississippi is the subject of the second paper. The investigation was prompted by the discovery that the songs of the Yuma Indians have a definite form, consisting of several periods recurring in regular order, a peculiarity which was afterwards found to occur sporadically among the Pueblos and the Seminoles, and as far away as the Tule Indians of San Blas, Panama. This characteristic, described as "period formation", was found also among the Choctaw, particularly in songs referred to be ancient. Numerous songs were recorded.

A paper entitled "Ethnological Data concerning 100 Yucatan Plants", by Morris Steggarda, is based on a collection made by him in the area occupied by the Maya Indians, near Chichen Itza. Having eliminated 125 species, about which the available data had already been published, he prepared the interesting report on the remaining 100, so that the information in it is entirely new. The body of the report consists of a catalogue, arranged in alphabetical order of scientific names, giving notes on the uses to which each is put by the Maya. This is followed by an alphabetical list of Maya names, and the paper ends with a discussion of the uses of the plants. Some are used, of course, for the production of various necessary objects and ornaments, but the greatest number are employed in the treatment of disease. It appears that the yerbateros, or herb doctors, have little scientific knowledge on which to base their treatments, which are in consequence a mixture of folklore, superstition and herbal concoctions, of which few have any curative value.

Steggarda is also responsible for "A Description of 30 Towns in Yucatan, Mexico", consisting of topographical and historical notes on a selection of the towns and villages he has visited. This should be useful to intending travellers in the area. (The first

of the description of the village of Mani is related at the beginning of that of Mama, where it does not make sense.)

Julian H. Steward's paper on Western Shoshoni myths does not claim to be exhaustive, but is published because information from this tribe in Nevada and eastern California was lacking. The tales are not new for the most part, and local variation is their most interesting feature, so as many different versions of the same tale as possible were collected. The title of one version of the "Theft of the Pine nuts" story is misprinted "The Origin of People".

The last paper, by Leslie A. White, on new material from Acoma, is a supplement to his book on the Acoma Indians, and contains miscellaneous information obtained since its publication. It includes a brief autobiographical sketch of an Indian, preceded by some particularly interesting notes on the mentality of the Pueblos, which sum up the difficulty of obtaining such material in the words "The autobiography of a Pueblo Indian is about as personal as the life story of an automobile tire".

G. H. S. BUSHNELL

THE STONE AGE IN SOUTH AUSTRALIA

A COLLECTION of reprints, all concerned with the stone age industries from certain parts of Australia, has been received*. The novel feature is the collaboration of Mr. H. V. V. Noone, who is an expert in the typology and technology of the older stone age industries of western Europe, and who therefore ensures that descriptive terms used there are all not to be employed to describe something different in the Antipodes. This is very important, as heretofore there has always been the danger that, for example, Australian tools described as burins might not really be burins at all. There are few good collections of European stone age industries in Australia, and Australian prehistorians have had to judge solely from pictures—never a very safe proceeding. If any kind of comparative work is to be done, a proper use of sensible descriptive terms universally is a *sine qua non*. It is to be hoped, then, that the above collaborators will extend their activities to other parts of Australia as well. Similar needs engender similar tools to deal with these needs, and it does not follow that there is any cultural connexion between distantly separated areas cause more or less similar tools occur in both. The same may be said of simple industries. Where the industries in the two areas, however, are complex and contain a number of specialized tools, the situation is altered and some cultural connexion may be postulated. Hence the necessity for accurate descriptions and descriptive terms.

In studying Australian stone age collections, one notes the not infrequent occurrence of pigmy types—triangles, crescents, tiny round scrapers, and the like. As these resemble not a little types occurring in the mesolithic industries of western Europe, prehistorians have been tempted to make close com-

parisons. Actually great care must be taken, because the occurrence of a pigmy industry denotes nothing more than the development of the composite tool—one in which the haft is made of some suitable material such as wood and the 'business' parts of flint and suchlike substances. Such composite tools could be, and were, developed at different times in different parts of the world. Their development probably depended largely on the incoming of climatic conditions allowing of the growth of softwood forests. The pigmy industries of Central India would seem to date from a century B.C. to the tenth century A.D., and those from Ceylon are also not very ancient. It must not be assumed, then, that the pigmy element in the Australian stone age industries is necessarily very old. Once the idea of the composite tool had been adopted, only a few types of pigmy artefact would be suitable—a chipped circle or square would be useless. The only form typical of the western European mesolithic cultures, and not occurring in India, Ceylon or Australia, seems to be the micro-burin.

Students interested in the comparative typology and technology of stone age industries should take note of the above-mentioned excellent descriptive articles.

M. C. BURKITT.

EFFECT OF HORMONES ON PLANT DEVELOPMENT

SINCE it has been shown that synthetic growth substances will supply the stimulus necessary for continued ovary development and hence fruit development in a number of plants, various attempts have been made to increase 'fruit set' in both 'fruits' and vegetables by the use of hormones. These attempts have met with varying degrees of success. L. Greene (*Proc. Amer. Soc. Hort. Sci.*, 42, 149, 1943) finds that a number of growth substances applied as sprays, lanoline pastes and injections to Starking apples failed to increase fruit set.

Similar negative results are reported by C. S. Pomeroy and W. W. Aldrich (*ibid.*, 42, 146, 1943), using naphthyl acetic acid on orange and grape fruit, although with the marsh grape fruit used, pollen of other grape fruit varieties did increase the set of fruit. On the other hand, R. H. Roberts and B. E. Struckmeyer (*ibid.*, 44, 417, 1944) found that aqueous solution of β -naphthoxy acetic acid and 2,4-dichlorophenoxy propionic acid sprayed on to tomato flowers induced fruit setting. *O*-chlorophenoxy propionic acid was less effective but both phenoxyacids caused distortion of the foliage.

The use of the sprays did not prevent fruit or flower abscission due to virus or to nutritional deficiencies. Favourable results from the use of these sprays were also found with pumpkins, outdoor cucumbers, egg-plant and *Nicandra physaloides* but not with apple (nine varieties), greenhouse cucumbers, peppers, potatoes, or strawberries.

In field experiments of a similar nature carried out by A. E. Murneek, S. H. Wittwer and D. D. Hemphill (*ibid.*, 44, 428, 1944) on snap beans, using naphthylacetamide and naphthoxyacetic acid applied as a spray to the plants every second or fifth day, increases in fruit yields were obtained in hot years, but decreases in cold years, emphasizing the importance of environmental conditions in determining the nature and extent of response to the treatments.

* Campbell, T. D., and Noone, H. V. V., "South Australian Microscopic Stone Implements", *Rec. S. Aust. Mus.*, 7, No. 3 (May 30, 1943). Campbell, T. D., and Noone, H. V. V., "Some Aboriginal Camp Sites in the Woorin Range, Region of the South-East of South Australia", *Rec. S. Aust. Mus.*, 7, No. 4 (Nov. 30, 1943). Noone, H. V. V., "Some Aboriginal Stone Implements of Western Australia", *Rec. S. Aust. Mus.*, 7, No. 3 (May 30, 1943). Noone, H. V. V., "Australian Material Culture", *Mankind*, 3, No. 5 (Dec. 1943).

FORTHCOMING EVENTS

(Meeting marked with an asterisk * is open to the public)

Saturday, February 10

ROYAL PHOTOGRAPHIC SOCIETY (SCIENTIFIC AND TECHNICAL GROUP) (at 16 Princes Gate, London, S W 7), at 3 p.m.—Mr J. Yarwood "The Deposition of Metal Films—their Application to Colour Photography"

Monday, February 12

FARMERS' CLUB (at the Royal Empire Society, Craven Street, Strand, London, W C 2), at 2.30 p.m.—The Earl De La Warr "British Agriculture and World Conditions"

ROYAL GEOGRAPHICAL SOCIETY (at Kensington Gore, London, S W 7), at 8 p.m.—Mr C. Hope Gill "The People and Country of Ethiopia" (with Kodachrome Film)

Tuesday, February 13

ROYAL ANTHROPOLOGICAL INSTITUTE (at 21 Bedford Square, London, W C 1), at 1.30 p.m.—Prof V. Minorsky "The Tribes of Western Persia"

CHEMICAL ENGINEERING GROUP (SOCIETY OF CHEMICAL INDUSTRY) (joint meeting with the INSTITUTION OF CHEMICAL ENGINEERS) (at the Geological Society, Burlington House, Piccadilly, London, W 1), at 2 p.m.—Mr J. Watson Napier "Ammonia Synthesis from Coke Oven Gas"

ROYAL INSTITUTION (at 21 Albemarle Street, London, W 1), at 5.15 p.m.—Sir George Dyson "The Origin and Development of Early Musical Forms", (1) "The Elizabethan Period"

INSTITUTION OF CIVIL ENGINEERS (MARITIME ENGINEERING DIVISION) (at Great George Street, Westminster, London, S W 1), at 5.30 p.m.—Mr A. L. Harvey "Two New Quays at Tyne Dock, South Shields"

ILLUMINATING ENGINEERING SOCIETY (at the Institution of Mechanical Engineers, Storey's Gate, Westminster, London, S W 1), at 6 p.m.—Discussion on the Report of the D. S. I. R. Committee on "The Lighting of Buildings" (Post-War Building Studies, No. 12) (to be introduced by Dr. C. C. Paterson, F.R.S.)

ROYAL PHOTOGRAPHIC SOCIETY (SCIENTIFIC AND TECHNICAL GROUP) (at 16 Princes Gate, London, S W 7), at 6 p.m.—Mr Stuart Williamson "Trends in Air-Camera Design"

INSTITUTION OF ELECTRICAL ENGINEERS (LONDON STUDENTS' SECTION) (at Savoy Place, Victoria Embankment, London, W C 2), at 7 p.m.—Dr W. Wilson "The Cathode Ray Tube and its Applications"

Wednesday, February 14

GEOLOGICAL SOCIETY OF LONDON (at Burlington House, Piccadilly, London, W 1), at 3 p.m.—Prof Owen Thomas Jones, F.R.S., and Prof William John Pugh "The Complex Intrusion of Welfield Rocks near Bulth Wells, Radnorshire", Dr Frank Dixey "The Relation of the Main Peneplain of Central Africa to Sediments of Lower Miocene Age"

ROYAL COLLEGE OF SURGEONS OF ENGLAND (at Lincoln's Inn Fields, London, W C 2), at 3.30 p.m.—Prof G. Grey Turner "The Hunterian Museum, Yesterday and To-morrow" (Hunterian Oration).

INSTITUTION OF ELECTRICAL ENGINEERS (TRANSMISSION SECTION) (at Savoy Place, Victoria Embankment, London, W C 2), at 5.30 p.m.—Mr R. C. Hutton and Dr J. McCombe "The Operation, Maintenance and Testing of Overhead Lines and Associated Outdoor Equipment on A.C. Systems"

ROYAL SOCIETY OF ARTS (at John Adam Street, Adelphi, London, W C 2), at 5.30 p.m.—Wing-Commander T. R. Cave-Browne-Cave "Camouflage for the Concealment of Civil Factories"

BRITISH ASSOCIATION OF CHEMISTS (at Caxton Hall, Westminster, London, S W 1), at 6.30 p.m.—Prof Harold Laski "The Place of the Scientist in Post-War Administration"

Thursday, February 15

CHEMICAL SOCIETY (at Burlington House, Piccadilly, London, W 1), at 2.30 p.m.—Mr L. C. Bateman, Dr E. D. Hughes and Prof C. K. Ingold, F.R.S. "Molecular Compounds between Amines and Sulphur Dioxide, a Comment on Jander's Theory of Ionic Reactions in Sulphur Dioxide", Mr S. H. Harper "Experiments on the Synthesis of the Pyrethrins, Part I, Synthesis of Chrysanthemum Monocarboxylic Acid", Mr N. Barton, Mr G. L. Buchanan, Prof J. W. Cook, F.R.S., Mr W. Graham and Mr J. D. Loudon "Studies on the Chemical Constitution of Colchicine"

ROYAL INSTITUTION (at 21 Albemarle Street, London, W 1), at 5.15 p.m.—Prof James Gray, F.R.S. "Locomotor Mechanisms in Vertebrate Animals", (3) "Nervous Control of Movement"

ROYAL AERONAUTICAL SOCIETY (at the Institution of Mechanical Engineers, Storey's Gate, St. James's Park, London, S W 1), at 6.30 p.m.—Mr J. Wright "Aircraft Wheels and Brakes"

Friday, February 16

ROYAL INSTITUTION (at 21 Albemarle Street, London, W 1), at 5 p.m.—Prof F. Wood Jones, F.R.S. "The Mammalian Toilet"

INSTITUTION OF ELECTRICAL ENGINEERS (MEASUREMENTS SECTION) (at Savoy Place, Victoria Embankment, London, W C 2), at 5.30 p.m.—Mr D. J. Desmond "The Economic Utilization of Modern Permanent Magnets"

INSTITUTION OF MECHANICAL ENGINEERS (at Storey's Gate, St. James's Park, London, S W 1), at 5.30 p.m.—Annual General Meeting Dr J. Lockwood Taylor "The Variable-pitch Marne Propeller"

Saturday, February 17

INSTITUTE OF PHYSICS (LONDON AND HOME COUNTIES' BRANCH) (at the Royal Institution, Albemarle Street, London, W 1), at 2.30 p.m.—Dr R. E. Slade "The Organisation of Research in Industry"

Saturday, February 17—Sunday, February 18

ASSOCIATION OF SCIENTIFIC WORKERS (at Caxton Hall, Westminster, London, S W 1)—Conference on "Science in Peace"

Saturday, February 17

At 2.15 p.m.—"Science and Production" (Chairman Prof P. M. Blackett, F.R.S.)

Sunday, February 18

At 10 a.m.—"The Future Development of Science" (Chairman Sir Robert Watson-Watt, F.R.S.)

At 2.30 p.m.—"Science in Everyday Life" (Chairman Prof E. Levy)

APPOINTMENTS VACANT

APPLICATIONS are invited for the following appointments on or before the dates mentioned

CHIEF LECTURER IN THE MINING DEPARTMENT—The Registrar, Technical College, Sunderland (February 16)

TEACHER OF MECHANICAL ENGINEERING SUBJECTS for the Da School of Engineering and Part-time Day and Evening Classes—The Principal, Hendon Technical College, The Burroughs, Hendon, London, N W 4 (February 17)

LECTURER (full-time) IN CHEMISTRY in the Science Department and an ASSISTANT MASTER or MISTRESS to teach MATHEMATICS to School Certificate standard, with some Elementary Physics or Geography, in the Technical High School attached to the College—The Clerk to the Governors, South-East Essex Technical College at School of Art, Longbridge Road, Dagenham (February 17)

ENGINEERS (temporary) for the Public Works Department of the Government of Nigeria—The Ministry of Labour and National Service Appointments Department, Central (T and S) Register, Room 5/1, Sardinia Street, Kingsway, London, W C 2 (quoting Reference N E 1212 A) (February 20)

PSYCHOLOGISTS (two or more, temporary)—The Secretary, Civil Service Commission, 6 Burlington Gardens, London, W 1 (February 21)

LECTURER IN BOTANY—The Secretary and Registrar, The University, Bristol (February 23)

ASSISTANT MASTER (full-time) to teach MECHANICAL ENGINEERING to Higher National Certificate standard and ALLIED SUBJECTS in the York Technical College—The Chief Education Officer, Educational Offices, Clifford Street, York (February 24)

SENIOR LECTURER IN AERONAUTICS in the University of Sydney—Prof A. V. Stephens, c/o Scientific Research Liaison Office, Austral House, Strand, London, W C 2 (March 1)

ENGINEER to take charge of all engineering and associated service in large old-established works in North Midlands area—The Ministry of Labour and National Service, Appointments Department, Central (T and S) Register, Room 5/17, Sardinia Street, Kingsway, London W C 2 (quoting Reference No. C 2453 XA) (March 6)

LECTURER IN METALLURGY—The Registrar, King's College, Durham (March 10)

CHAIR OF ANATOMY in the University of Ceylon—The Secretary, Universities Bureau of the British Empire, c/o University College, Gower Street, London, W C 1 (March 19)

PROFESSOR OF PHILOSOPHY, tenable in the Durham Division of the University—The Registrar, University, 46 North Bailey, Durham (March 31)

ASSISTANT KEEPER to be responsible for the GEOLOGICAL COLLECTIONS in the Manchester Museum—The Registrar, The University, Manchester 13 (April 24)

LABORATORY ASSISTANT (skilled) FOR PHYSIOLOGY DEPARTMENT The Vice-Dean, St. Bartholomew's Hospital Medical College, Queen's College, Cambridge

SECRETARY AND TECHNICAL EDITOR—The Secretary of the Technical Section, Paper Makers' Association, Melbourne House, Aldwych, London, W C 2

PSYCHOLOGIST (part-time) for the Child Guidance Clinic—The School Medical Officer, Public Health Department, Stour Street, Canterbury

RESEARCH ASSISTANT, with medical qualification, or degree in biological subject, in the Department of Chemotherapy—The Laboratory Secretary, Liverpool School of Tropical Medicine, Pembroke Place, Liverpool 3

REPORTS and other PUBLICATION

(not included in the monthly Books Supplement)

London Shellac Research Bureau. Lac Derivatives as Substituents for Alkyd Resins. By Dr B. S. Gidvani and N. R. Kamath. Pp. (London: London Shellac Research Bureau, 1944.)

Ministry of Health. Nurses Salaries Committee. Mental Nurses' Sub-Committee. Further Recommendations. Mental Nurses' Notes No. 1. Pp. 4. (London: H.M. Stationery Office, 1945.)

Parliamentary and Scientific Committee. Annual Report, 1945. Pp. 19. (London: Parliamentary and Scientific Committee, 1945.)

Catalogue

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SCIENCE IN THE FOREIGN SERVICE

THE departure of Prof. Eric Ashby for Moscow to take up his position as scientific attaché, with the rank of counsellor at the Australian Legation, to which he has been appointed, as recently announced (*Nature*, Jan 20, p 72), marks the first step in fulfilment of a proposal which has been increasingly discussed during the last two years. The interruption of communications by war conditions has of course made it necessary to improvise new organizations now that contacts of men of science are fewer and less easily arranged and even the publication of scientific and technical papers may require to be withheld temporarily or in part. Experience gained during the War with such organizations as the British Central Scientific Office in Washington, the American Scientific Office in London, the Anglo-Soviet Science Collaboration Committee, and the Scientific Co-operation Office of the British Council in China goes far to suggest that, even when normal means of communication and intercourse are fully restored, such organizations may still have a valuable part to play.

That much appears in the specific recommendations of the report of the British Commonwealth Science Committee, set up under the chairmanship of the President of the Royal Society in October 1941. Reporting in the summer of 1943, this Committee suggested the maintenance of permanent scientific and technical representation in London and possibly also in other capital cities of the English-speaking countries, in association so far as possible with representatives of the United States and others of the United Nations. This idea has since been further developed by Dr J Needham in his article on "An International Science Co-operation Service" (*Nature*, 154, 657, 1944), where the further suggestion is put forward that the proposed Service should have permanent representatives in all countries and regions, with diplomatic or 'League-official' status, and guaranteed Government facilities for communication and transport.

This line of thought goes far beyond that of the mere exchange of information or even of personnel. As Dr. J Needham has pointed out, the staff of a Science Co-operation Bureau in its work of collecting and disseminating scientific information must be familiar with the conditions of scientific and technical life and thought in the country where they are stationed. They must possess the confidence of the resident diplomatic personnel and be competent to advise them authoritatively on problems relating to science and technology. They must be unfailingly at the service of the Ministers of the Government departments concerned with science.

It is at this point, where the advantages of diplomatic status as suggested by Dr Needham are most apparent, whatever its disadvantages in other respects, that we meet another trend of thought which has also thrown up the idea of scientific

attachés Despite the welcome which the Government's proposals for the reform of the Foreign Service received generally in 1943, there was widespread agreement that they did not provide sufficiently for the introduction of a scientific outlook into the Service or the capacity to appreciate the importance of scientific and technical questions. Lacking that capacity or outlook, diplomatists cannot function effectively as intelligence officers in the modern world, and Sir Victor Wellesley, who recognizes clearly that essential function among various constructive proposals in his recent book "Diplomacy in Fetters" (Hutchinson and Co., Ltd., 1944), says that. "Scientific, industrial, and mineralogical attachés may soon have to be added." In a close survey of some aspects of the work of the Foreign Service, Political and Economic Planning in a broadsheet "The Future of Foreign Publicity" pointed out that an ambassador or minister is responsible for all the official contacts between his country and that in which he works, and he cannot escape a measure of concern for many of the unofficial contacts as well, since they may react upon the international relations which it is his primary duty to oversee and conduct. For this reason P.E.P. believes that after the War the number and range of specialist officials may be increased, particularly in the general field of economics, and attachés to Embassy staffs for nutrition, agriculture and labour are particularly indicated, and possibly other attachés concerned with the Colonies or colonial policy.

The suggestion which Lord Samuel threw out in the House of Lords' debate on scientific and industrial research on July 15, 1943, regarding the appointment of scientific attachés to the principal British embassies abroad, or that Great Britain should be provided with scientific liaison officers competent to bring to the notice of those interested at home the progress and methods which have been achieved or established in other countries, thus fell on well-prepared soil. It has been taken up by the Parliamentary and Scientific Committee, which has prepared a confidential memorandum on the subject in the light of views obtained from various sources. The memorandum, after reviewing existing arrangements, recommends a formal inquiry into the whole question by the Government with representation of the Foreign Office, the Fighting Services, the Departments of Overseas Trade and of Scientific and Industrial Research and the British Council. The memorandum was adopted by the Committee on December 12, 1944, and has been sent to the Secretary of State for Foreign Affairs.

While this idea of scientific attachés has been widely discussed from both points of view, no practical steps have so far been taken in the matter, though Great Britain has an agricultural attaché in Washington. Among scientific men it appears to find widespread approval, for it is recognized that if the common attack on some of the scourges of mankind is to be organized effectively on international lines, in the way in which Prof. J. M. Mackintosh, for example, suggested in his review of preventive

medicine at the recent British Association meeting, some further means of integrating knowledge and power will be required. At a recent dinner at which Prof. Ashby was present, the whole question was discussed and his appointment stimulated much favourable comment.

It has been left, however, to Australia to give lead to the British Commonwealth and Empire in this matter, but Prof. Ashby's short visit to Britain will have convinced him that he carries with him the keen interest and the good wishes of scientific workers here. As already indicated, his appointment to Moscow is for about a year, and it should be clear from the note that has already appeared in *Nature* how well qualified Prof. Ashby is to act as a pioneer in a matter of close concern to the whole scientific world. Obviously a scientific attaché must be prepared to move across the frontiers of many different branches of science and to concern himself with interdisciplinary questions involved in teamwork and the corporate attack with different techniques on a common problem. Prof. Ashby aims at working in a laboratory for a time, but the U.S.S.R. and Australia have many problems in common, especially in agriculture and animal husbandry. By concentrating more or less on these problems at the start, Prof. Ashby may well find it easier to get the experience and the sympathy and understanding which will assist the handling of more general and perhaps more delicate questions, whether of co-operative research or the exchange of personnel.

This appointment is only a start, and it should be obvious that the appointment of scientific attachés can never be fully successful unless the traffic is in both directions. Prof. Ashby hopes that one result of his mission will be the visit of a Russian man of science to Australia, not as attaché, but to work in one of the laboratories and to study Australian science in general, he hopes also, if the U.S.S.R. approve, to arrange for an Australian man of science to pay a like visit to Russia. Whether in fact such interchange can be arranged remains to be seen, but Prof. Ashby can be assured that his work in Moscow will be closely and sympathetically followed by fellow men of science in Britain.

There can be no illusions as to the difficulties of this experiment or the demands it may make on Prof. Ashby's tact and scientific and organizational ability. Much may be learnt from it, but scientific workers in Great Britain will be at one not merely in wishing Prof. Ashby success but also in hoping that we will not be slow to follow the example and enterprise of the Commonwealth of Australia. Only if such steps are taken in the future can we hope to be ready to organize effectively, on the world-wide scale demanded, for scientific and technical co-operation in the attack on the problems of the post-war world, and on the continuous application of scientific knowledge to problems of human welfare, on both of which the realization of a new world order of freedom from want, disease and fear depends.

MUCH ABOUT THE SOYBEAN

bybean Chemistry and Technology

by Klare S Markley and Warren H. Goss. Pp. vi+261 (Brooklyn, N.Y. Chemical Publishing Co., Inc., London: Macmillan and Co., Ltd., 1944) 5s net

THAT versatile oriental bean, the soybean, has been a long time coming into its own among Anglo-Saxons. For many years it has been a staple product in China and Manchuria where, according to travellers' tales, all sorts of uses were made of it. After the War of 1914-18 it came to Britain in quantity, the beans having their oil 'solvent extracted', and uses were sought for the cake both as animal feed and as a source of protein for humans. A serious check was given to its use when cattle were injured by it owing to the presence of a poisonous glycoside. The oil was not too well liked by the soap-maker, it was not so 'soft', that is, unsaturated, as cotton seed oil, or hard enough to replace tallow, and the cost of hardening it by the catalytic process was not remunerative. Lastly, the growing of it was not understood either in Britain or in America.

During the last decade all this has abruptly changed, at least in the United States. It is stated that soybean now leads in the production of edible oil, having outstripped cotton seed oil, while the cake, as a superior protein ingredient for livestock and poultry food, has become of great utility. More important, soy flour in various forms is gaining in popularity—it is an ingredient of rations, included in bakery and other food products, and is sold direct to housewives. This latter applies to Great Britain so where soya flour, which we are beginning to learn how to use, has become a valued additional source of protein.

As protein shortage is one of the most serious deficiencies which ail the world of the future, the importance of the soya bean as an easily grown high-yielding source of it cannot be gainsaid. One question will be the nutritive value of this particular kind of protein, having regard to its constituent amino-acids. There is thus considerable scope for a work on the chemistry and technology of soya, which this book seeks to provide—it is apparently sponsored by the Soybean Nutritional Research Council. Soybeans have fortunately proved to be a profitable crop in the corn belt of the United States, hence the willingness to extend their cultivation. During the last ten years, the acreage has increased tenfold, and the yield per acre has gone up by nearly 50 per cent; hence the production is almost fifteen times as great, a major extension taking place during the war years. A large amount of applied science has contributed to this result. There are many hundreds of types and strains, and the bean is peculiarly sensitive to changes of soil and climate, so that elaborate studies have been necessary to increase the yield and quality under local conditions.

The beans average 40 per cent of protein and 20 per cent of oil, with upper limits of 50 per cent and 24 per cent respectively. They are remarkable for being a rich source of the enzyme urease. The sugars include two of the rare ones, raffinose with 18 carbon atoms and stachyose with 24 carbon atoms. The glycosides comprise saponins, phytosterols and isoflavones. The oil has about 2 per cent of phosphatides.

The first part of this book gives a useful summary of the chemical components of soy, and includes about a hundred references to the original literature. The

second half deals in some detail with the processing mainly for oil, but contains also the most modern development of the production and refining of phosphatides. More than a hundred oil mills are listed as extracting the oil, an example of how quickly such an industry can be established. Soy flour is dealt with in a dozen lines only—it would appear that there is still much to do with it before it becomes a large-scale human food, one had expected to find much more under this head.

The book is probably mainly intended for practical use by those directly concerned with soybeans in one way or another, and as such is a model of what a really helpful text-book can be. It is easily written, concise and full of information not otherwise available.

There is no reason why Britain should not grow and process soybeans, provided a race can be found which fits in with the vagaries of our climate. Indeed, the Ministry of Agriculture ought to give direct encouragement to such work, for Britain just cannot afford to be left out of such modern progressive development. The day is definitely passed when we can be content to import the product of other men's enterprise and brains and stand still at home. If wool can be made from arachis protein, surely soya protein may prove an alternative source.

We can confidently recommend the book to those interested in the soybean. E. F. ARMSTRONG

SINGING BREEZE

War-time Harvest

Poems by Marie Carmichael Stopes. Pp. 92 (London: Alexander Moring, Ltd., 1944) 5s.

ALTHOUGH this choicely arranged volume of poems provides us with a further example of the author's versatility, I do not feel that Dr. Stopes is, as yet, sufficiently co-ordinated as a poet to be justly classified.

As Lord Alfred Douglas very rightly affirms in the preface to this collection—"adequate matter and form are here"—but despite this invaluable framework and a particularly fresh singing quality, there is often a falling-off of brushwork within the frame. "Instead of Tears", for example, dedicated to men who lost their lives on H.M.S. *Cossack*, containing as it does some of the finest lines in the volume, at the same time serves to illustrate the author's variability of treatment:

"Brown berried sea-wrack tangles round your throat
In festive chaplets where no fresh wreathed flowers
Will reach you, and your resolute white limbs
Are draped with laminarias crinkled strands"

A lovely stanza with an ease and flow of music possible only to the true poet, yet in the following stanzas we meet these all too familiar clichés—"this foul war", "nightmare fiend", "bright future full of happy toil". Surely a decline from the unobtrusive elegance of the quoted passage.

Thus we are borne along throughout the book in a series of such undulations between superb sweeps of melody, much admirable thought which, alas, often wilts into the banal.

I think, perhaps, the author's sustained lyrical vigour tends to obscure her critical faculty in this way. How else explain the inclusion of such verse as

"You are
So far
I lie
And cry"

The strongest aspects of these poems are their directness of wording and vision, which make for easy reading. Dr Stopes is never obscure, and whether it be a tribute to Homer or to a flower, she tackles her subject with fearlessness and generous sympathy. But in contrast one must again mention the admixture of quality, for there is an odd combination of high-mindedness coupled with an almost youthful naivety of emotional expression discernible in these poems at times. One is reminded somewhat of the patriotic fervour prevalent at the beginning of this age.

Nowadays, the 'singing' poet needs to be very much on his guard lest he strike a note which is ineffectual rather than false when attempting to reflect current thought and feeling. The younger poets with their sober metre appear to manage this with more firmness of touch than can a transitional writer diffused between two vastly differing periods of time.

The shorter poems "To the Beloved", "If", "Judas" and "Ode to the South Wind"—the latter being an especially well-balanced work—all avoid pitfalls, and serve as admirable examples of the author's possibilities.

In summing up, I would describe this book of Dr Stopes as 'interesting', and with her many advantages of masterly style and appropriate imagery, she will no doubt eventually make the necessary adaptations to place herself within a more definable radius as a poet.

MARGARET HOWARD

A SOUTH AFRICAN DIVINE RULER

The Realm of a Rain Queen

A Study of the Pattern of Lovedu Society. By Dr E Jensen Krige and J D Krige (Published for the International Institute of African Languages and Cultures) Pp xvi+336+16 plates (London, New York and Toronto Oxford University Press, 1943) 21s net

GENERAL SMUTS, in his foreword, commends this book as one of the most honest and penetrating researches into native life that he has come across. The tribute is well deserved. Dr and Mrs Krige selected a fascinating subject for study. The Lovedu, living among the mist-covered mountains of northern Transvaal. Insignificant as regards numbers and the extent of their territory, 33,000 tribesmen occupying a reserve of 150 square miles, their reputation was, and still is, great among the Bantu of South Africa, their queen was held to be the most powerful of all rain-makers, and even chiefs so distant and renowned as Chaka and Moshesh sought her aid in extremity. Many foreign ambassadors and potentates gathered at her court, bringing cattle or daughters or sisters to win the favour of "Transformer of the Clouds". To Europeans she was a mystery, was reputed to be very light-coloured (Was she really a white woman?) and to be immortal. Rider Haggard familiarized her as "She-who-must-be-obeyed". There is substance in the fantasies that gathered about her. She figures as one of the Divine Rulers of whom Sir James Frazer has written.

In 140 years there have been three Lovedu queens,

the present Mujaji III having reigned more than forty years. The first king was a scion of the fam Monomotapa, mighty monarch of the Vakaran, whose sons divided the realm among themselves at his death. By incestuous union with her brother the daughter of one of these chiefs bore a son who fled the country, carrying off the rain charms and sacred beads, and in course of time gathered about her a new community in the south, the Lovedu, various origin. The queen is neither a military nor political leader. She is not primarily a ruler but rain-maker, what authority she exercises derives from her divine appointment and her exclusive power of controlling the rain, ensuring its fall for her friends and denying it to her enemies. The tribe relies for security not on regimentation, armies and organization, but on this power of the queen.

The rain-cult is a whole complex of institutions with ramifications through many aspects of tribal life. It is perhaps scarcely accurate to describe the queen as a rain-maker, she is so intimately connected with the forces of Nature that her life seems to be continuous with them, anything that affects her affects Nature. She is the guarantor of the cyclical regularity of the seasons, when she dies the seasons are out of joint. She has a monopoly of magic; anyone who should presume to enter into competition with her by practising garden magic would incur the penalties of witchcraft. There are certain limitations to her power: no one would expect her to produce rain in the winter, she relies upon diviners to diagnose the causes of drought, people can thwart her by certain infringements of taboos and ultimately, it is recognized, her power depends upon the divine ancestors. Dr and Mrs Krige maintain that belief in her virtue is universal and unshaken among the Lovedu—the Christians rationalize this belief by saying that she produces rain by the help of God.

How exactly the rain-queen exercises her power is a secret known only to herself, but it is known that certain 'medicines' are employed. These are kept in earthenware pots, Dr and Mrs Krige never saw these, but learnt that among the contents are human or more human skulls and the skins stripped from the bodies of deceased chiefs and councillors. A black sheep, said to be a substitute for a human child, is sacrificed from time to time to reinforce the medicines. The queen has no husband but many wives, some of whom, after a certain period, are allocated to nobles, and by this means a network is formed radiating from the queen all through the community.

One effect of having a queen of such divine authority is the elevation of the status of women in patrilineal society. Lovedu tradition is that the king or queen never dies a natural death: he or she commits suicide, not when their natural vigour fails, but at the end of the fourth initiation during the reign, and these initiation ceremonies are held at intervals from twelve to fifteen years.

Dr and Mrs Krige provide a very full exposure of the social organization and activities of the people. Having been challenged for a long period by Western civilization and having been percolated for much longer by various Bantu cultures, the Lovedu are a fruitful field for the study of culture contact and culture change, and the authors' findings on this subject are an important part of a very valuable contribution to social anthropology.

EDWIN W. SMITH

APPLICATION OF INFRA-RED SPECTROSCOPY TO CHEMICAL PROBLEMS

It was once said that in planning its discussions the Faraday Society does not follow scientific fashion and need, but anticipates them. This comment would apply well to the symposium held at King's College, London, on January 2, on the "Application of Infra-red Spectra to Chemical Problems". The large attendance of physicists and chemists from both university and industrial laboratories, as well as the diversity of subjects discussed, showed that this is a field of considerable interest and potentiality both for routine and research purposes in chemistry. The striking advances in the experimental technique of infra-red measurements during the past ten years are described in a joint comprehensive paper from the laboratories at Oxford and Cambridge, where Drs H. W. Thompson and G. B. B. M. Sutherland and their colleagues have vigorously explored all aspects of the problem. As Sir Robert Robertson remarked, it is not many years since the difficulties of obtaining stable thermo-electric systems for the accurate measurement of infra-red radiation made it necessary to work at night, and the exacting conditions were magnified, since many hours or weeks might be needed to cover a significant spectral range. Recent developments of prism spectrometers have been mainly directed towards greater speed of measurement, stabler and more sensitive detectors, and automatic recording of the spectral absorption. By incorporating new vacuum thermocouples of rapid response and high sensitivity, automatic continuously recording instruments have been developed which can be used in routine laboratories without elaborate experimental precautions or difficulty.

Single-beam recorders, however, suffer from the disadvantage that atmospheric water vapour and carbon dioxide give rise to an irregular background, which complicates the determination of percentage absorption in some spectral regions. The most recent improvement is to use a double-beam spectrometer, in which the energy of a blank beam of radiation is measured against that of a similar beam into which an absorbing substance has been placed. The two beams are focused separately on thermocouples, and the electromotive forces produced are fed, after amplification, into a quick-acting potentiometer recorder having a rapid speed of response. In this way the absorption spectrum can be obtained as a direct record of percentage absorption—or if required optical density—against wave-length, so that the arrangement becomes entirely automatic. While this type of instrument surpasses the hopes of a few years ago, still further improvements may eventually result from the use of bolometers.

Interesting exploratory work on a thermocouple-bolometer detector was described by Dr G. E. T. Mun. Another noteworthy feature is the production, by cooling the molten solids, of large blocks of alkali halides having high optical quality and suitable for use as prisms.

Apart from the spectrometers themselves, development of the accessories has been marked. A convenient absorption cell for studying molten solids is described by R. E. Richards and Dr H. W. Thompson, and several speakers outlined methods for the accurate determination of the thickness of such cells. The most favoured methods are based on

interference phenomena using either infra-red, visible, or ultra-violet light, and examples were given by Dr G. B. B. M. Sutherland, H. A. Willis and by Dr W. C. Price. For many purposes, infra-red spectra of substances have to be measured in solution, and the solvent will have its own absorption bands which may mask those of the solute. In order to survey the spectrum of a given solute over a wide spectral range, it will therefore be necessary to use several solvents. P. Torkington and Dr H. W. Thompson set out the spectral transmission curves of a large number of common solvents, which should serve as a useful reference in selecting the most convenient one for use for any particular spectral region.

Turning to the applications themselves, the infra-red absorption spectrum emerges as another physico-chemical tool for analysis in organic chemistry. This is perhaps the most significant general contribution from recent progress. Absorption bands arise from the absorption of molecular vibration frequencies the magnitudes of which depend upon the nuclear masses and the forces between them. Since no two molecules, other than a pair of optical isomers, have exactly the same nuclear structure and potential energy function, the vibrational spectrum will be a characteristic property of the molecule, and perhaps the most characteristic yet known. Drs H. W. Thompson and G. B. B. M. Sutherland reviewed the principles by means of which these theoretical considerations can be applied to the practical problem of analysis, and examples of mixtures studied by their collaborators were given. A very striking case is the analysis of mixtures of the three isomeric cresols, which can be carried out rapidly with fairly high accuracy; but from the varied assortment of examples given it was clear that the method can be used generally. It is very useful for determining small amounts of impurity in reagents, fine chemicals, solvents and important compounds of biological and pharmaceutical interest. Dr Thompson mentioned a case in which a crude solid product containing four stereoisomers could be analysed with comparative ease in about half an hour. The factors which determine the sensitivity for detecting a particular component, and the accuracy obtainable in analysing a mixture, were discussed. As foreshadowed in his Tilden Lecture to the Chemical Society last year¹, it seems certain that infra-red analysis will soon become a standard method for the control of purity of organic substances.

Other applications of the infra-red are mostly connected with the elucidation of molecular structure, but whereas past work has dealt almost exclusively with smaller molecules, the absorption bands of which could be resolved into rotational fine structure from which moments of inertia might be determinable, measurements have now been made with macro-molecules, and a wealth of information has been derived from them. Examples of many kinds were discussed. Thus, Dr D. M. Simpson examined critically the infra-red data on ozone in relation to electron diffraction measurements, and tried to obtain an assignment of the normal vibration frequencies which is consistent with the spectral data, and which simultaneously gives plausible values for the apical angle and bond force constants on the basis of simple valency force field. As the author explained, the arguments and results obtained are not free from objection, and suggest that a more detailed analysis of the rotational fine structure of the infra-red and Raman bands should be carried

out, at the same time the way in which all the evidence has been correlated and examined provides a good example of this class of work.

In another paper dealing with the force fields within molecules, Dr J W Linnett reported calculations on the variation of the force constants of C—H, N—H, O—H, S—H and other M—H bonds in series of molecules. The characteristic vibration frequency of such linkages is always much higher than those of other normal vibrations, since for practical purposes the light hydrogen atom oscillates against a much heavier effectively rigid residue. By virtue of this, it is possible to use simple formulae for calculating the force constants of these links and still obtain results which must approximate closely to the true values. In this way Dr Linnett has made a valuable compilation of the C—H force constants as affected by adjacent groups. In methyl fluoride the value is low as compared with methane, whereas in the other methyl halides it is normal. In methylamine and methyl alcohol, and even in ethane too, low values are found, and these are very well explained in terms of the contribution of different ionic structures towards a resonance hybrid. Dr Linnett's analysis of the data shows that other factors affecting the force constants are the type of carbon bond orbitals used, namely, sp^3 , sp^2 or sp , and the extent to which there is a positive charge located on the carbon atom. Analogous computations were made for the other M—H bonds, and the whole work should be of great value for future reference.

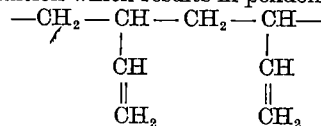
How the rotational contour of absorption bands of the vapours of relatively light molecules can be used with other data to determine the fundamental frequencies of a molecule was illustrated with reference to fluorinated ethylenes by P Torkington and Dr H W Thompson. A comparison of the vibration frequencies of vinyl fluoride with those of the other vinyl halides revealed unexpected peculiarities. The presence of the fluorine atom brings about a marked decrease in the values of the deformational frequencies of the C—H bonds at the other end of the molecule, whereas with the light fluorine atom the reverse might be expected. Similar effects are found with vinylidene fluoride, $CH_2=CF_2$, and with $CH_2=CFCl$. We can interpret these changes as arising from some electronic effect transmitted through the carbon-carbon double bond, or as Dr Price put it, in terms of the contributions of ionic structures towards the molecular resonance hybrid. Related to this, too, are the alterations found in the C=C vibration frequency in the different compounds, for in passing from ethylene to vinyl fluoride there is a small increase, and when two fluorine atoms are attached to the same carbon atom, as in vinylidene fluoride or tetrafluoroethylene, it is even higher. Another feature is the very high intensity of absorption of vibrations due to stretching of C—F bonds, particularly when CF_2 groups are present, and this must again be connected with the variations of polar character of the linkages during compression. These data open up a new line of inquiry into the reasons for the well-known anomalous chemical and physical properties of compounds containing carbon-fluorine bonds.

With macro-molecules such as rubbers, plastics, and resins, which are nearly always examined in the solid state, the infra-red spectra consist of bands arising from absorption of the fundamental vibration frequencies, or overtones or combinations of them, and this is the only information about the molecule which the spectrum gives. It is therefore remarkable

to find that a considerable amount of information about the structure of these molecules has already been derived. Dr Thompson presented an extensive survey of the spectra of many classes of compounds of high molecular weight studied with his collaborators during recent years, and illustrated by select examples the sort of questions which can be answered by this approach. The primary aim of the work is to correlate internal molecular structure and the mode of packing of large molecules with their physical behaviour, particularly in regard to flow and electric characteristics. The main principle is that where the complete spectra of two molecules should never be exactly the same, yet particular links, groups, skeleton units may have a frequency or set of frequencies which persist almost unchanged through a large number of molecules in which they occur. Reference data on simple molecules are first obtained; it will then be possible to detect or estimate such groups, and if enough data of this kind are available, crucial information about the macro-molecule may be inferred.

Polythene, originally thought to contain a long chain of CH_2 groups, is found to contain a few pendent methyl groups, and weaker bands can be correlated with other unexpected units in the nuclear skeleton. When dienes such as 1,3-butadiene, or 2-dimethylbutadiene, polymerize to form the different varieties of rubber, 1,4-addition may occur leading to long 'straight' chains such as

$-CH_2-CH=CH-CH_2-CH_2-CH=CH-CH_2-$
or 1,2-addition which results in pendent vinyl groups



The amount of branching in a long-chain polymer of this kind is known to have a profound effect on properties such as ease of vulcanization or use as a lubricant. Chemical methods involving ozonolysis were worked out by Simonsen and others some years ago, but the infra-red method is both quicker and neater. It depends on the fact that different classes of olefines have spectral features which are characteristic for each type. There are key wave-lengths for (1) the vinyl compounds $RCH=CH_2$, (2) the substituted isobutylenes $R_1R_2C=CH_2$, and (3) the *cis-trans* olefines $R_1CH=CHR_2$, and estimates of the amount of each type can be made from measurements of the absorption intensity at the key wave-lengths. These principles were illustrated with reference to samples of buna and methyl rubber, and analogous correlation with other hydrocarbon polymers such as crepe rubber and polystyrene were outlined. The determination of 1,2 or 1,4 addition applies in a similar way to the interpolymerization of butadiene with acrylonitrile or styrene. In such cases, too, the proportions of the components in the interpolymer can be estimated, and minor changes in the structure of an interpolymer as the combining ratio changes can be explored by changes in the infra-red spectrum.

Another class of polymer discussed by Thompson and Torkington included the polyvinyl and polyacrylic esters, and the spectra of some of these compounds were considered in relation to such features as head-to-head or head-to-tail condensation. A comparison of the spectra of polyvinyl chloride, polyvinylidene chloride, and those of halothenes (chlorinated polythenes) seemed particularly interesting. As the percentage of chlorine introduced into the polymer

increased, well-defined changes in the spectrum occur, and it may be possible to discover how the chlorine atoms are distributed along the long carbon chain. It is noteworthy that the spectra of polyvinyl chloride and polyvinylidene chloride differ from those of halothenes containing the same percentage of chlorine. Other compounds studied include polyvinyl alcohol, nylon, polyester waxes and novolac resins, and in each case structural features of value are obtained. Cellulose ethers and esters have also been examined, and in structural diagnosis the new method promises to be an important supplement to X-ray work, while for practical purposes the identification and determination of hydroxyl groups, aceto or butyryl groups could be valuable.

Other general matters discussed by Thompson and Parkinson included the differentiation of a polymer and its monomer, and the possibility of correlating spectrum with chain-length; and attention was also directed to the use of polarized infra-red radiation with oriented films of certain polymers.

Dr. Sutherland mentioned similar work on polymers carried out with Mr. Ramsay and Mr. Harding. Differences had been found between certain samples of polystyrene and of poly-isoprenes, and structural differences had been made.

N. Sheppard and Dr. G. B. M. Sutherland described measurements on the spectrum of rubber after vulcanization and 'curing' by various reagents, the changes which occur during these processes can be followed by changes in the spectrum. Thus, if stearic acid and stearic acid are used in the curing process, a band appears in the spectrum due to the carboxylate ion, which disappears again as the vulcanization proceeds. It is interesting also to find that, in the early stages of vulcanization at least, the band due to the carbon-carbon double bond in crepe rubber remains almost unchanged in intensity. The latter result was confirmed by Dr. Thompson in some similar studies in which rubber was treated with sulphur chloride vapour for different periods. In this case new bands were found in the spectrum which may be connected with sulphur-sulphur or carbon-sulphur linkages, and comparisons are required with the spectra of simple alkyl sulphides and disulphides.

Mr. C. G. Cannon discussed measurements on the infra-red spectrum of coal and coal extracts, and showed how various important groups may be identified in the samples. Although this work is so far exploratory in character, it indicates already that a new attack is possible on the differences between coals of varied origin.

Mr. H. A. Willis outlined similar measurements carried out with Dr. Sutherland on the infra-red spectrum of diamond, a subject investigated some years ago by Sir Robert Robertson and the late Dr. John Fox. The new measurements suggest that another type of diamond has been found, and the authors stated that Sir C. V. Raman and his colleagues have recently misinterpreted Raman data. In the discussion, Sir Robert Robertson directed attention to the errors in measurement of the intensity of absorption bands which may be caused by scattering losses. Whatever the real explanation, it is clear that further measurements of this kind may lead to important knowledge about the different kinds of diamond.

The Faraday Society is to be congratulated on organizing this stimulating discussion.

Chem. Soc., 183 (1944).

GORDON COLLEGE AT KHARTOUM

UNIVERSITY COLLEGE STATUS

By E. N. CORBYN

Former Principal of the College

A FORMAL inaugural opening of the reconstituted Gordon Memorial College at Khartoum will take place on February 20.

When in 1898 Lord Kitchener had won the battle of Omdurman, which opened the Sudan to civilization, and then went home to receive the thanks of his grateful fellow-countrymen, his first action was to ask for and receive from them by public subscription £100,000 for the building and endowment of a college at Khartoum in memory of General Gordon, for the education of the Sudanese.

In 1902 his return from the South African war gave him the opportunity to open the fine buildings erected on the bank of the Blue Nile, not far from the Palace where Gordon died. Those whom he had left behind in the Sudan, General Sir Reginald Wingate, his successor as governor-general, his young brother-officers of the Royal Engineers who had taken charge of the new country's public works, Mr. (later Sir) James Currie, whom Lord Cromer had chosen as the first director of education, all had laboured to carry out the beginnings of his intention. What was his ultimate purpose he placed on record at the opening ceremony, when he said: "All I hope and trust is that it may be found this centre that development of higher education in the Sudan may be focused for all time".

The site allotted for the Gordon College was one of the best on the Khartoum river-front, and by far the most extensive. It covers many acres and includes, besides space for the buildings, ten football grounds intersected by avenues of shady trees. Its eastern boundary lies close to the Blue Nile Bridge, and along the road and railway embankment that makes a wide circular sweep round to the railway station behind the city of Khartoum. The main building, with a central block and two wings, is a large and impressive structure, the design making use of wide and lofty verandas, suitable to provide shade from the violence of the tropical sun. Inland from the playing-fields are large boarding-houses, and the grounds contain also other educational buildings and staff houses.

Currie's task, as the first director of education in the Sudan, was to inspire with the breath of life the bricks and mortar which Kitchener had provided. This he had to do by bringing into the Sudan an adapted blend of Western and Arab education. He had seen the blend as approved in Egypt during a short period of service under Dr. Douglas Dunlop in the Egyptian Ministry of Education, which had enabled him to form his own ideas. In the *tabula rasa* of the Sudan, where he arrived in 1900, his opportunity was unique, and nobly he took it.

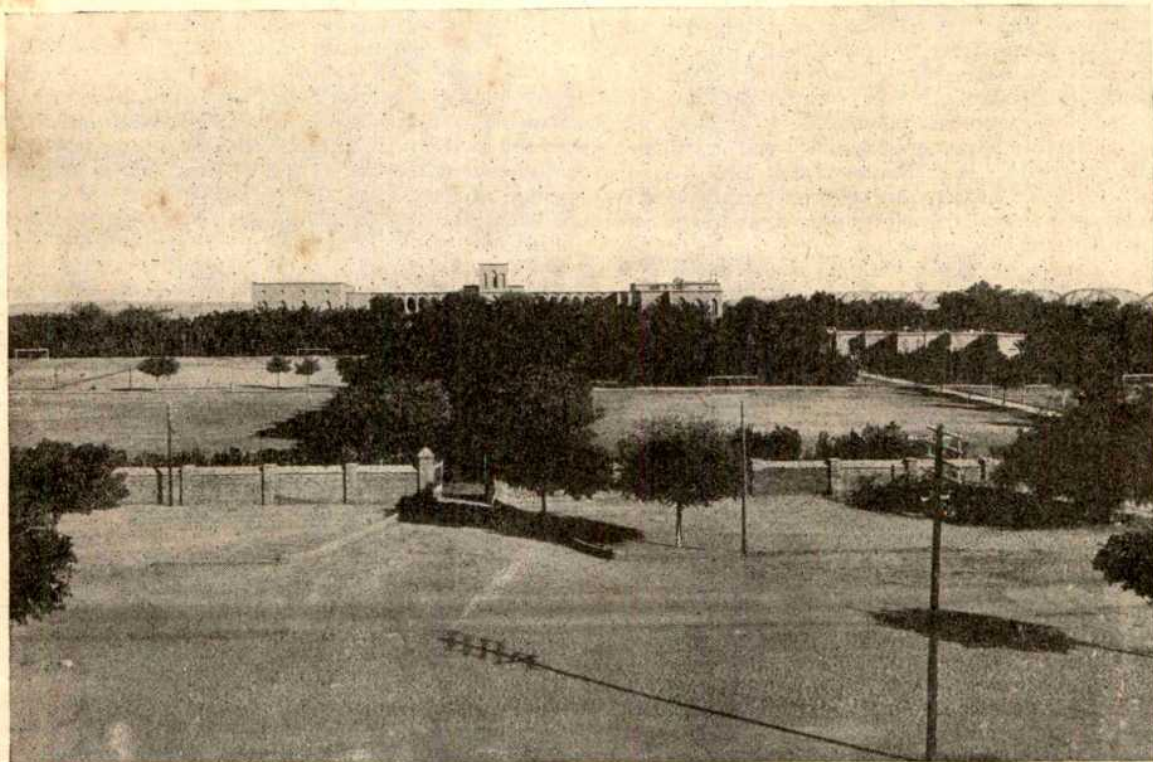
It was Currie's view that, at all events in the early formative years, the director of education should be also the principal of the Gordon College. He held that thus the College could best be integrated with the general educational machinery of the country, which also he was devising and installing, so he was insistent on presiding over both.

Even when, in its beginnings, to the ordinary man the College seemed to consist of a few Sudanese boys

being taught by (at first) Egyptian teachers to become the future teachers of their fellow-countrymen (for so, of course, it had to start), Currie, with the eye of faith and imagination, saw it already as in part a university. He held that, if one side of his duties was to commence imparting instruction at the lowest level, another side was to have in the same buildings working examples of human knowledge at its highest level. So he gathered into his College all those branches of scientific research so necessary in a new land, but which, to be successful, must work in a congenial home. The new Government needed medical research, chemical research, entomological research, geological research. Currie opened to all of

Carter, was in process of establishing. These were to deal with matters of the personal law of the Sudanese (marriage, divorce, inheritance, etc.), which in the Arabic-speaking parts of the country are almost universally Mohammedans. Soon learned Sheikhs from the ancient University of El Azhar in Cairo were teaching promising classes in the study of their own religious law. The religious law courts of the Sudan have thus come now to be presided over by Sudanese 'Kadis', or judges.

At the lower levels the College housed at first what had to begin as education of the primary school stage. This developed into secondary school education, with vocational courses in the latter stages for



THE GORDON MEMORIAL COLLEGE FROM THE SOUTH (INLAND) SIDE, SHOWING PLAYING-FIELDS AND THE BLUE NILE BRIDGE IN RIGHT BACKGROUND.

them his arms and his buildings. He grouped them under him as principal of an institution in which research of highest university standard could work and flourish. This was only not a university because its brilliant staffs were there to do their own work on the problems of the country, and not, at that stage, to teach or give diplomas or degrees.

Such was Currie's conception. It was not always understood, even by fellow-workers in different spheres of the Sudan's administration. But what mattered was that he had brought it to birth and it existed, and it made the Gordon memorial buildings on the Blue Nile a centre of light and learning from the very start of the great enterprise for which they had been designed.

Meanwhile the early stages of education for the Sudanese went steadily forward. Currie was quick to seize on one indigenous branch as already of university standard—the study of Mohammedan law for the staffing of the Mohammedan law courts which the first Legal Secretary, Mr. (later Sir) Edgar Bonham

engineers, teachers, and clerical Government staff. When the numbers in the secondary school grew so fast as to fill the buildings, the primary school was extruded and became the Khartoum primary school, housed elsewhere. Similarly, other primary schools were established in the other larger towns of the country, and became feeders for the secondary school in the Gordon College. This was often spoken of as though it alone was the Gordon College; but, as will have been seen from the details given above, the College was much more.

Such was Currie's Gordon College when he retired in 1914, and in essence it remained the same under his immediate successors. I was myself the third principal and director of education during 1926–27. My own suggestion for the next stage was to extrude the junior two years of the secondary school, to develop the four-year-course primary school which fed it into six-year-course intermediate school and then to add two more senior years to the secondary school course, thus taking it two years further on

into higher education. Changes remained in abeyance, however, until the whole Sudanese system of education was considered and reported on in 1937 by the De La Warr Commission. This Commission went further and recommended the extrusion of the whole four years of the secondary school course, and the transfer of the secondary school or schools elsewhere, so that the way might be clear at the Gordon College for the establishment of education at a post-secondary, or university college, stage.

Such was the programme which Mr Christopher Cox, the sixth principal, taking up the De La Warr Commission's recommendations with admirable zeal and skill, was able to lay before the Sudan Government. In spite of the impact of the War on the country's finances, the Government decided to carry it out. The design included two (at first) secondary schools, placed in different parts of the country outside Khartoum, to which the secondary school in the Gordon College would be transferred. The buildings for the first of these, at Wadi Seidna on the Nile north of Khartoum, were just being completed as the War began. These buildings and the buildings of the Gordon College itself had then to be requisitioned for military purposes. The secondary school, instead of going to Wadi Seidna, had to find temporary accommodation opposite Khartoum in the big native city of Omdurman, where it still remains until Wadi Seidna is free for its occupation.

The Gordon College buildings were released in 1944, thus removing the structural bar on the constitution of the new University College, the plans for which now took final shape. The early vocational courses had been developed into schools for education at a professional level. It was the grouping of these schools that was designed to constitute the University college.

In November 1944 there took place at Khartoum the first formal meetings of a Council set up to administer the College in that capacity. This Council becomes the authorized delegate for that purpose of the Executive Committee of the Gordon Memorial College in London, under powers given to that Committee by the trust deed made when Lord Kitchener collected the endowment.

Included in the new College are six post-secondary schools—the School of Arts (which includes a School of Law), the School of Science, the School of Engineering, the School of Agriculture, the Khartoum Veterinary School, and the School of Administration and Police. This new united body of post-secondary schools now takes over the name, the buildings and the endowments of the Gordon Memorial College.

The reconstituted College will still leave outside its present framework two Sudanese educational institutions of post-secondary rank, the Kitchener School of Medicine at Khartoum, and the Institute of Education at Bakht er Ruda, which is in a rural setting on the White Nile about 120 miles south of Khartoum. The Kitchener School of Medicine, founded in 1924, though linked also with the Executive Committee of the Gordon Memorial College in London, has endowments subscribed in the Sudan and a constitution of its own. In addition to the income of its own endowments, it receives an annual subvention of a thousand guineas from the Lord Kitchener National Memorial Fund in London. The Institute of Education is established and administered by the Sudan Education Department. Both will be brought into organic relationship with the new University College due course.

The College now, as a university college, will have a principal of its own, other than the director of education, and Dr J D Tothill, recently director of agriculture and forests in the Sudan, has been nominated as the first holder of that post. The constitution devised for the College on university lines gives to its Council a large measure of independence from the Sudan Government. It is the Government's desire and purpose to grant to it, as soon as the money can be made available, ample endowments of its own, for which a figure of £3,000,000 is aimed at.

It remains to give some brief account of the details of the Schools of the College, which branch respectively from the School of Science and the School of Arts.

The School of Science has preparatory courses for the Kitchener School of Medicine, the Veterinary School, the School of Agriculture, the School of Engineering, and for teachers of science going to the Institute of Education. In 1945 it will commence also a three-year diploma course of its own.

The School of Medicine has a six-year diploma course, the School of Engineering a four-year one, and the Veterinary School and the School of Agriculture grant their diplomas after three years.

The School of Arts has a four-year diploma course in law, and three-year diploma courses in history, English, Arabic and geography. A two-year course is the condition for entry to the arts teachers' section of the Institute of Education, or to the School of Administration and Police, or to certain government employments.

Members of the new Gordon College inherit the fine hostels and beautiful playing-fields established in the past. These fortunate young Sudanese will have at their disposal all that is necessary for the building up of healthy minds in healthy bodies. The educational history of the Sudan in the past forty-five years leaves little doubt that they will rise to their opportunities.

THE PEATS OF NEW JERSEY

TWO recently published bulletins¹ provide a broad picture of the peat bogs of New Jersey. If these are read in conjunction with other publications², one is given a wide purview of American east-coast peat bogs from Maine to Florida. In these various bulletins there is in particular very detailed information about the maritime peats, both the salt marsh and the mangrove types. One is chiefly impressed, however, by the scale upon which this study of the New Jersey peats was carried out. The investigation was treated as an official Work Projects Administration project, and fifteen to twenty-five field-crews of five men each were engaged upon it in addition to office and laboratory staff, so that the total number employed was at one period about 150 persons. There is still scope for investigations on this scale in the British Isles, and it is to be hoped that the end of the War may see similar projects in being. In particular, British peat bogs or salt marshes would be eminently suited to this type of treatment, and in view of the possible value or use of such land for agricultural purposes there would seem to be a strong case for Government support of any such research programme on a commensurate scale.

The first bulletin is introductory in nature, and provides a general survey of peat as a whole. The

terminology associated with peat is discussed in some detail, especially the use of the word 'muck', which is employed for certain important agricultural soils in the United States. This word appears to have two meanings, in one case it refers to a mixture of decomposed peat and mineral soil, while in the other case it is used commercially for non-acid or low-moor peat. Four classes of peat are recognized: (a) hochmoor, (b) lowmoor (including salt marsh peats), (c) swamp or forest peat, and (d) aquatic or alluvial peats, though these latter contain such a high percentage of sedimentary material that their claim to be termed peat may be questioned. In discussing the factors influencing peat formation, insufficient attention has perhaps been paid to correlations between pollen analysis and the historical development of the region. Godwin and his co-workers in Great Britain have shown how much can be achieved in this direction. The pollen diagrams are indeed inadequate and disappointing, and it is to be hoped that a further bulletin may be devoted to this important aspect. It must, however, be admitted that the survey was largely undertaken with the agricultural possibilities of the peat soils as the pervading background. Similarly, in discussing the microbiology of the peats, there is little or no mention of the part played by the mycorrhiza which are associated with many bog plants.

While the first bulletin contains much information that is of great value, it is largely a summary of existing information as applied to New Jersey peat bogs. The second and more substantial bulletin gives an account of the actual results obtained by the field parties and the laboratory analysts. This information is given in considerable detail, and after perusing it we are left with an extensive picture of the characteristics of the principal areas and peat bogs throughout the State.

Hochmoor or blanket bog peat is practically unknown in the State, and there are very few bogs composed of sphagnum remains. Out of 91-114 million acres of peat bogs in the United States, the State of New Jersey claims about 500,000 acres. In the areas surveyed the proportions of the different types were more or less as follows: lowmoor or fen peat, 20,961 acres; salt marsh peat, 100,725 acres; swamp or forest peat, 56,241 acres; fresh water alluvial peat, 28,357 acres. Topographically, New Jersey can be divided into four regions, the Appalachian Valley, the Highlands, the Piedmont plateaux and the Coastal Plain. In the lower part of the Appalachian Valley the bogs frequently rest on Kittatinny limestone and they differ from those elsewhere due to the influence of this substratum. It can also be shown that many of the bogs have developed in depressions associated with the terminal moraine of the Wisconsin ice-sheet, but there are others, especially smaller bogs, which are associated with the numerous 'Kame' moraines.

The pollen analysis diagrams indicate that peat formation commenced in the boreal period. This was followed first by a *Pinus* era and then by oak and hemlock. For purposes of description, the State is divided into twenty-one drainage areas each with its own system of bogs. These bogs formed approximately 60 per cent of the areas surveyed, and the average size of a bog was about 9,800 acres, but they ranged from 241 to 35,711 acres.

The northern peat bogs are all of the lowmoor or fen type, though one large forest (cedar) swamp is described from the Hackensack region. *Carex* is the

principal peat-forming plant in these bogs at the present day, but the numerous sections through the bogs show that two general types of deposition have occurred. In one case there is a sedimentary layer at the base, while in the other there is a shell marl from a relict *Chara* phase. On these basal layers there is commonly a *Phragmites* peat followed by a *Carex* peat with a further zone of decomposed *Carex* peat on top. The *Phragmites* and non-decomposed *Carex* layers may contain the remains of tree stumps.

The other three types of peat bog are primarily confined to the coastal plain region. Some of these peat bogs are of very considerable size, for example, the great cedar swamp six miles long and two miles wide at its broadest, and the salt marsh peat area at Great Egg Harbor thirteen miles long and six miles wide. The salt marsh peats have average depths of 3-4-15 ft with maximum depths of 16-34 ft. The maximum tidal ranges along this stretch of coast, as given by the U.S. Coast and Geodetic Survey, vary from 1 ft to 6 ft, since the depth of the peat commonly exceeds the maximum tidal range, subsidence of the coastline must have taken place during the formation of many of the marshes. These salt marsh peats usually possess three well-defined zones: a basal *Zostera* zone, a middle *Spartina glabra* zone and an upper *S. patens* zone. In spite of continual flooding by salt water it was found that the peats tended to have an acid reaction, said to be due to the reduction of sulphates to sulphides by bacteria. This is in distinct contrast to the alkaline peats of the southern mangrove swamps of Florida and the West Indies. If this is indeed true, one may question whether the salt marsh peats should be classified with the lowmoor or the fen peats, as is suggested in the first bulletin.

The freshwater alluvial peats are mainly restricted to the Lower Delaware basin, and are found north and west of a line joining Asbury Park, Colts Neck, Farmingdale, Clarksburg, New Lisbon, Berlin, Malaga, Millville, Delmont and South Dennis. While the salt marsh peats are a prominent feature of the coastal plain region, the forest peat swamps of the New Jersey pine barrens are of equal importance. Two types of forest peat bog can be distinguished: there is first the cedar swamp type with *Chamaecyparis thujaoides* as the dominant tree and, secondly, the deciduous swamp type with pitch pine and white oak as the dominants. The profiles of the bogs show that whole regions of the coastal plain have been covered in the past with forests of white cedar and that these forests have been submerged by the sea, have then emerged and been submerged again. Many of the forest swamps are juxtaposed to tidal marshes which in their turn generally lie behind protective barrier beaches. The balance between the forest swamps and the tidal marshes is delicate and one passes readily to the other or vice versa depending on the upward or downward movement of mean sea-level. Sufficient data should now be available to make it possible to determine whether such sea-level movement is in fact taking place at present. The forest peat is underlain either by sand or by silt and reed peat or by *Carex* peat, the lower layer often containing numerous tree stumps.

This second bulletin is profusely illustrated with profiles across bogs of all types from the many different regions and with the relevant analytical soil data. It is to be hoped that the latter, which are not as extensive as one could wish, will be augmented in a further bulletin. There is no doubt that

the organization and scope of this study should prove a model upon which investigations in other parts of the world might well be based.

V. J. CHAPMAN

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OBITUARIES

Sir Thomas Barlow, Bt., K.C.V.O., F.R.S.

THOMAS BARLOW, who died in London on January 12, was within eight months of his hundredth birthday, which he would have well liked to see. Brought up in the cotton belt of Lancashire, in a household where character—rough hewn but solid—was the ruling factor, he was endowed with a good memory and a power of observation that has made famous naturalists, and his span covered a century in which medicine has progressed geometrically. If the wattage of life may be taken as a multiple of duration, brilliance and worth, no wonder Barlow has left a mark on his contemporaries. His middle period as popular consultant and physician to three reigning over-queens—Robert Bridges said he knew no medical man with a more intimate personal sympathy with his patients—was preceded by a period in which he faced a common childish disorder to its origin as a efficiency disease, and was succeeded by an Indian summer in which he used his experience and still bounding energy to guide a benevolent fund which gave a sense of security to the declining days of less successful practitioners.

The early period is the one which deserves elaboration here. In 1874, when Barlow became registrar of the Hospital for Sick Children in Great Ormond Street, the hand-feeding of infants had taken a turn towards artificial foods and sterilized milk, with the result that what was called 'acute rickets' began to come to the notice of clinicians. Barlow's colleague, Dr B. Cheadle (following Ingerslev in Sweden), suggested that here was scurvy grafted on the familiar tokens of rickets, but when Barlow came to make his classical study of thirty cases, published in 1883, it was evident rather that here was a ear-cut deficiency disease, namely, infantile scurvy, due simply to exclusion from the diet of something essential to healthy growth and development. It took another fifty years for the nature of scurvy to become generally recognized and the appropriate vitamin supplied. But for the first step which counts highly, Barlow earned his election to the Royal Society in 1909 and the less glittering reward of curing the disease he had described known abroad as *Barlow's disease*.

E. C. M.

NEWS and VIEWS

Galton Chair of Eugenics at University College, London.
Dr. L. S. Penrose

DR L. S. PENROSE, who has just been appointed to the Galton chair of eugenics at University College, London, studied philosophy at Cambridge and proceeded to Vienna in 1923 for postgraduate work in psychology. On returning to England he took a medical degree, and during 1930-39 was research medical officer to the Royal Eastern Counties Institution at Colchester. His report on 1,280 mental defectives and 28,921 of their relatives has put the whole problem of mental defect on a new basis. Congenital mental defect may be due to single dominant genes such as that for epiloia, to single recessive genes such as that for phenylketonuria, or to numerous partially dominant genes, in which case it is inherited like other quantitative characters studied by Pearson. There are probably hundreds of types, each ultimately distinguishable clinically, with its characteristic mode of inheritance. He has paid particular attention to pre-natal environment in connexion with mongolism, placenta prævia and pyloric stenosis, and was the first to estimate the mutation-rate of an autosomal human gene. Since 1939 he has worked in London, Ontario, particularly on the genetics of insanity and on personnel tests for the Canadian Army.

Pearson and Fisher, the first occupants of the Galton chair, came to eugenics from mathematics, via statistics; Prof Penrose comes from psychology via medicine. If his views are accepted, the eugenic movement will become a good deal more concrete. It may be no more possible to wipe out mental defect than to abolish fever, but appropriate eugenic measures might reduce certain types of defect as drastically as hygiene has reduced typhoid fever, while other types would not be reduced. Prof Penrose will use the statistical methods developed by his predecessors, but he will use them on data which have been provided by up-to-date clinical and psychological methods.

Botany at University College, Nottingham

DR C. G. C. CHESTERS has been recently appointed to the chair of botany at University College, Nottingham, in succession to Prof T. A. Bennet-Clark. Prof Chesters graduated in the University of Glasgow where he received his botanical training under the leadership of Prof Bower and took up an appointment at Birmingham in 1927. From 1930 onwards, when he became lecturer, his energies were devoted mainly to the study of mycology, and he became reader in mycology in 1942. During this period, Prof Chesters built up a flourishing school of mycological research. His chief mycological interests have been in the Pyrenomycetes and Phycomyces. His work on British Pyrenomycetes, published in a series of papers from 1935 onwards, must rank as an important contribution to the study of the life-histories and taxonomy of the group and he is justly recognized as an authority in this field. More recently, Prof Chesters has been experimenting with new methods of approach to the difficult problem of the study of the fungus flora of the soil, and he has designed special 'immersion tubes' whereby fungi can be directly isolated from the soil. Prof Chesters' mycological activities are by no means confined to the university, for he is a prominent and active

We regret to announce the following deaths

Dr G. D. Elsdon, chief inspector of the Lancashire Rivers Board and formerly chief county analyst for Lancashire, on January 18, aged fifty-six.

Prof C. B. Lipman, professor of plant physiology at the University of California, on October 22, aged fifty-one.

member of the British Mycological Society, serving as secretary during the period 1936-42 and becoming a vice-president in 1942

Botany at University College, Leicester

MR. T. G. TUTIN has been appointed lecturer in charge of the Department of Botany, University College, Leicester. Mr Tutin obtained his degree at Cambridge (Downing College) in 1930. He was demonstrator in botany at King's College, London, during 1938-39, and assistant lecturer in botany at Manchester during 1939-42. Recently, he has been working for the Admiralty. He visited British Guiana in 1933 and was a member of the Percy Sladen Trust Expedition to Lake Titicaca, Bolivia, in 1937.

Military Health Services in the U.S.S.R.

STRIKING figures in regard to the decreased death-rate among wounded Soviet soldiers were given by Dr. S. A. Sarkisov, professor of neuropathology at the Moscow Institute of the Brain, in the course of an address to the Pharmaceutical Society of Great Britain on February 8 on the health services of the Soviet Union. He said that modern warfare, involving huge armies, with its extreme mobility, its complicated tactics and strategy, and its swift wedges driven into almost completely devastated areas, has changed the whole structure of the organization of the medical service and lays entirely new demands on it, especially where first aid is concerned. Further complications are added by the use of new and powerful weapons such as mines, splinter bombs and so on. Whereas in the War of 1914-18 the majority of wounds were caused by bullets, in the present War they are due to mine and other splinters. These provoke grave wounds, extremely susceptible to infection. Despite all this, important progress in wound treatment has been made. During this War there have been only isolated cases of gas gangrene, the percentage of amputations is considerably lower than during 1914-18, the death-rate caused by bladder wounds has been reduced to a very great extent. Further improvements have resulted in a remarkable decrease of the death-rate among wounded men in the hospitals. This rate is now only 1.1 per cent, and the percentage of wounded men who have returned fit to the front is now 73 per cent. During 1914-18 it was 40 per cent. In addition, there have been no epidemics in the U.S.S.R. This is all the more significant when it is remembered that the considerable medical problems connected with the large-scale transfer of industries to the eastern parts of the country took place in the early stages of the War.

The Cinematograph Film in Medical Education

In a leading article on the uses of the film for medical education, the *Lancet* (601, Nov. 4, 1944) reminds us that Dr. Braun filmed the mammalian heart in 1897 and, in that year also, Schuster, of Berlin, filmed the abnormal gait of some of his patients. The first surgical operation was filmed by the famous French surgeon, Doyan, in 1898. Yet in 1941, the *Lancet* directed attention to the fact that academic circles in Great Britain had then scarcely noticed "this new weapon." Those who were medical students in Manchester in the days of that great and progressive teacher of physiology, Prof. William Stirling, will remember the thrill they had when Stirling returned one day from Paris, to which

he was a frequent visitor, with a film of trypanosomes in the blood. This must have been about 1906-10.

Since those days the film has become a different thing. How valuable it may be we may learn from the articles by C. J. Longland and Ronald McKeith and by B. Stanford in the *Lancet* (*loc. cit.*, pp. 585 and 588). Longland and McKeith deal with the present use of the film for medical education, and the supply of films and information, giving a valuable list of organizations from which medical films can be obtained. They also discuss the use of medical films abroad, the question of how they can help medical education, plans for their use and the job of their production. Stanford gives his article to this problem of production and to the scope of the medical film. In the same issue of the *Lancet* (p. 615) is a note on the apparatus used in one of the laboratories of Imperial Chemical Industries, Ltd., for cinematography, and on another, more elaborate apparatus for high-power cinematography designed by R. McV. Weston (see also *Nature*, November 4, 1944, p. 573).

The Research Defence Society

THE annual report of the Research Defence Society, published in the *Fight Against Disease* (32, 2, 1944), records further progress during 1943 and a gratifying response to the appeal for funds made in 1943. This has given the Society an additional £140 a year and an addition of £530 to its invested reserve, which now stands at its highest figure in the Society's history. But its total annual receipts of about £1,000 compare sadly with the statement also made, that opponents of animal experiments have spent, during the last thirty-two years, some £750,000 of charitable money in their efforts to stop experiments requiring the use of animals. The Society hopes, nevertheless, to resume its full activities after the War, under the presidency of Lord Hailey, who succeeds the late Sir William Bragg. The annual report directs attention to the success of diphtheria immunization and to the importance of vaccination in the control of smallpox demonstrated by the recent outbreaks in London and Glasgow. The Society's publications on these and similar subjects are being used to counter systematic efforts to prejudice mothers against protection of babies against smallpox and diphtheria by sending them misleading pamphlets at hospitals and nursing homes.

The present issue of the *Fight Against Disease* contains, in fact, short articles on the part played by animal experiments in the study of various grave diseases, which should be valuable in countering anti vivisection propaganda. The late Sir John Ledingham contributed a list of important advances due to or greatly helped by, experiments on animals, among which are the prevention of diphtheria, tetanus (the menace of which has been virtually excluded from the British and American Armies during the present War), typhoid, cholera, plague, rabies and smallpox; the diagnosis of syphilis, typhoid and paratyphoid typhus, tuberculosis in cattle and such virus infection as influenza and yellow fever also require the use of animals; the sera for the detection of human and animal blood stains in criminal and other investigations are obtained from specially immunized animals and animals also provide the sera used for the treatment of diphtheria, tetanus, gas gangrene, dysentery typhus and other diseases.

Sir William Savage discusses the relation of animal experiments to the control of typhoid and other

infectious diseases, tuberculosis, venereal disease and to other problems of public health and nutrition. Prof. J. H. Burn discusses their relation to the standardization of such therapeutic substances as insulin, neoarsphenamine and various antitoxic sera. Dr. J. W. Trevan further discusses physiological, immunological and therapeutic researches done with animals for the control of human and animal diseases, instancing diabetes, rickets, beriberi, pellagra, diphtheria, gas gangrene and, in veterinary medicine, lamb dysentery (which used to kill hundreds of thousands of new-born lambs each year) and louping ill of sheep. He states that tuberculosis has been virtually eliminated from cattle in the United States by the use of tuberculin for its diagnosis. We also owe the sulphonamides entirely to work done with animals, and many other drugs cannot be standardized without the use of them. Prof. George Wooldridge discusses the relief of pain and suffering in animals themselves due to experiments done on animals.

Tyndall's Library

MESSRS. H. SOTHERAN of 2 Sackville Street, Piccadilly, W.1, have just issued an annotated catalogue of works on physics comprising the library of John Tyndall (1820-93), professor of natural philosophy at the Royal Institution, and including also other items. Of special interest are such unique items as a manuscript catalogue of the library with nearly two thousand entries, together with numerous scientific notes of Prof. Tyndall and short autobiographical details of his boyhood. Another notebook of seventy pages contains notes of his original drafts of papers and reviews with suggestions of experiments to be made. A great deal consists of personal notes, not without their humorous aspect. Of Forbes he writes, "The late Principal J. D. Forbes was a man not slow to anger. He was so sensitive as to his fame, and so eager to secure it that honest criticism was regarded by him in the light of personal attack"—typical English understatement remembering the Forbes-Rendu-Tyndall glacier controversy. Other notes connected with Ruskin and Prof. Tait include "I have heard Prof. Tait described as a rude overgrown schoolboy". The same note-book contains the first draft of his sensational presidential address at the Belfast meeting of the British Association. The catalogue of more than a thousand items includes many volumes with Tyndall's pencilled notes. Such rare works as a first edition of Huygens "*Traité de la Lumière*" with the full name on the title-page also appear.

Industrial Safety in Spain

A PAPER by Luis Ruiz-Castillo Basala entitled "Eliminación de accidentes en la 'Industria de la Construcción' por el conocimiento del factor humano" appears in *Revista De Formacion Y Documentacion Profesional* (3, No. 9. Madrid, 1944), dealing with the problem of obviating accidents to those included in the category of the "Industria de la Construcción". The investigation was conducted for this class only, which includes twenty-four different forms of employment, constituting about 70 per cent of the manual workers in Spain (agricultural workers are excluded). Each of the occupations is examined separately, and the most relevant conditions which characterize them are given under the headings of physiology, psychology, hygiene and other factors.

It is believed that accidents could be eliminated to a very large extent in the branches of industry referred to by attending to certain points, among which may be noticed the following: (1) Selection of those most adaptable to the particular type of work. This could be effected by a physico-technical examination of special type, starting with a study of the characteristic enumerated for the various forms of employment (2) Psychological influence by means of conversation etc., on those who come under examination, to help each one to make use of his psychological qualities in the fulfilment of his daily occupation (3) Propaganda by means of posters, handbills, and so on, having the special object of eliminating accidents. These would teach people the most convenient positions to adopt at their work and the most rational methods for proceeding with it, and would also show the necessity for remembering on all occasions the attitudes of security most fitted to avoid foreseen risks.

Announcements

THE Buchan Prize for 1945 of the Royal Meteorological Society has been awarded to Mr. E. L. Hawke, secretary of the Society.

THE Secretary of State for the Colonies has made the following appointments to the Colonial Products Research Council: Mr. J. C. F. Fryer, secretary of the Agricultural Research Council, in succession to the late Dr. W. W. C. Topley; Prof. H. V. A. Briscoe, head of the Department of Inorganic and Physical Chemistry, Imperial College of Science and Technology, in succession to the late Sir John Fox, Government chemist.

THE Council of the University of Sheffield has made the following appointments: Mr. J. H. Read, to be lecturer in chemistry; Dr. E. F. Finch, to be honorary lecturer in the history of medicine, in succession to Mr. George Wilkinson; Mr. J. Carson, to be honorary lecturer in psychology in the Faculty of Medicine, in succession to the late Dr. E. F. Skinner.

OWING to the generosity of the Rockefeller Foundation of New York, which has for a fifth year in succession provided a grant for the purpose, the Royal Society is in a position to give assistance to scientific societies and associations which, as a result of war conditions, are experiencing financial difficulties in the publication of scientific journals.

A WHOLE-DAY conference of the Nutrition Society will be held on February 24, beginning at 11 a.m., at the London School of Hygiene and Tropical Medicine, Keppel Street, W.C.1. The subject of the conference will be "Factors Affecting the Nutritive Value of Bread as Human Food". Further details of the Nutrition Society can be obtained from the Hon. Secretary, Dr. Leslie J. Harris, Nutritional Laboratory, Milton Road, Cambridge.

WE have received from Messrs. Griffin and Tatlock, Kemble Street, Kingsway, London, W.C.2, particulars of some apparatus and materials, including a neat balance desiccator, polishing alumina for metallography, an anti-vibration balance table, a Kjeldahl apparatus for determining nitrogen in steel, and several other types of analytical apparatus. Publications on these may be obtained on request.

LETTERS TO THE EDITORS

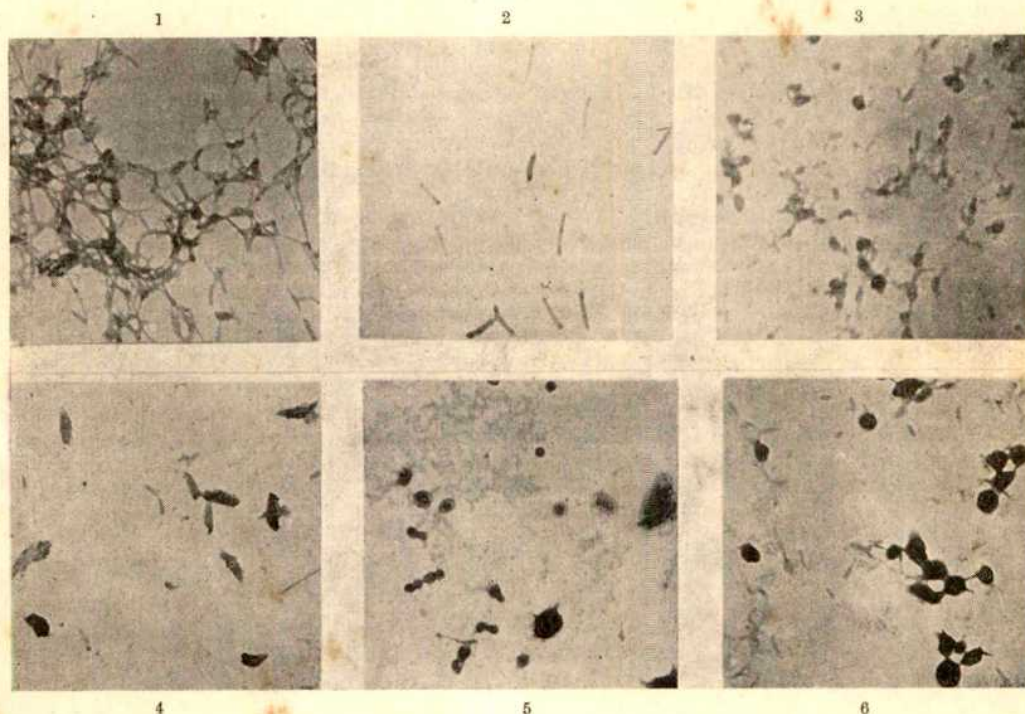
The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications.

Electron Microscopic Investigation of Precipitates of Cellulose Nitrates

THE preparation of cellulose for electron microscopy is very difficult, because it implies the necessity of disintegrating the fibres to very thin fragments (10^2 – 10^3 Å.). Different mills combined with swelling agents have been used, but the difficulties are not overcome by these methods. The results obtained do not always agree, and different conclusions have

was performed from a dilute acetone solution (0.02 gm./100 ml.). If the water was added slowly at about 50° C., with vigorous shaking, the cellulose nitrate formed an opalescent sol showing a distinct Tyndall effect. It was stable for many hours at a water concentration of 80 per cent. After standing for one or more days, the sol partially coagulated to filaments or lumps without definite shape.

In the electron microscopic investigation we used object membranes of nitrocellulose lacquer (cellulose nitrate containing about 12 per cent N dissolved in amyl acetate) of a thickness of about 50 Å. We worked at a magnifying power of 20,000 (electron microscope with magnetic lenses from Siemens and Halske A.G.). The preparations were made by dry-



1. Sulphite cellulose (spruce), bleached and treated with strong alkali, α -content 98 per cent (Mo och Domsjö AB).
2. Sulphate cellulose (pine), bleached 'Kraft' pulp (Uddeholms AB).
3. Sample removed from a sulphite cellulose cooking (spruce) 9 hr. 45 min. after start (the cooking was completed in 19 hr.). Lignin content 16.6 per cent before nitration. The nitrate was completely soluble in acetone.
4. Russian raw cotton linters, not extracted or treated in any way, α -content 96 per cent. The nitrate dissolved to 96 per cent in acetone.
5. Sulphite cellulose (spruce), bleached to extremely low viscosity by hypochlorite.
6. The cellulose from Fig. 1, depolymerized to half the original intrinsic viscosity by the 'ageing' of alkali cellulose in the viscose process.

been drawn on the structure of the cellulose¹. Of great value are the comparisons with light and electron microscopy made by Eisenhut and Kuhn², Barnes and Burton³ and others. Good pictures have also been published by Husemann and Carnap⁴. In the investigations reported hitherto, preparations have been made by disintegrating fibres. Preparation by precipitating cellulose from cuprammonium solution has been used only in one case⁵. Precipitations of cellulose derivatives for electron microscopy do not seem to have been used at all. We have tried to get electron microscopic preparations of cellulose nitrates precipitated from acetone solution by water. The following is a preliminary report on these experiments.

The cellulose nitrates investigated were nitrated by a mixture containing phosphoric acid⁶, and they contained about 13.8 per cent N. The precipitation

ing up a drop of the opalescent solution on the object membrane.

In these preparations there were different structures of the particles, and we have tried to classify them. As a preliminary description, the three main types of structures may be characterized as follows.

1. *Micellar structure*, that is, straight rods or threads of rather uniform thickness and definite shape, sometimes lying free from one another but often crowded like a net over the membrane (length ~ 2000 Å. and thickness ~ 100 Å.). See Figs. 1 and 2.

2. *Amorphous structure*, that is, lumps or clods without definite shape and magnitude. See Figs. 3 and 4.

3. *Fine-grain bottom- or understructure*, that is, extremely thin formations, sometimes lying as a net but not so strictly ordered as the micelles. The

ottom-structure was often to be seen, together with the amorphous structure. See Figs. 5 and 6.

Using the method described, we have found that celluloses of extremely high molecular weight ($DP > 10,000$ from sedimentation and diffusion measurements) give mainly amorphous structure (type 2, see Figs. 3 and 4) and no, or very few and irregular, micelles. Celluloses of moderate molecular weight ($DP \sim 1,000$) have a definite tendency to form micelles (Figs. 1 and 2), sometimes all the precipitate is of type 1. We have not been able to obtain micellar structures of this type from celluloses delolymerized in different ways to very low molecular weight ($DP \leq 300$), they form precipitates of type 2 and 3, often mixed, but sometimes thin and irregular micelles were observed in the bottom-structure.

The lengths of the micelles observed are about 1 per cent of those computed from DP (sedimentation and diffusion measurements) for straight molecules. The lengths agree rather well with those of the molecules computed from the frictional ratio according to the formulae given by Burgers' (cf. Fig. 8). The frequency curves of the lengths are narrow and show only one peak, the mode of the lengths varied from 1000 Å to 3000 Å for different samples.

We believe that the micelles observed are crystallites, and it is possible that they are identical with the micelles proposed for the structure of cellulose and its derivatives in the solid state.

There are celluloses with only small differences measured by the general methods of analysis (viscosity, content of α -cellulose, pentosans, lignin, ash, extractive matter and so on) but of very different value for technical use. By using the precipitation method described, we have found distinct differences between such pulps, too. Possibly the method may be used for the characterization of technical celluloses. Further experiments are in progress and the results will be published elsewhere.

We wish to thank the director of the Institute, Prof. The Svedberg, for his interest in this work and for helpful criticism. We also thank the Mo och Domsjö AB and the Uddeholms AB for financial support.

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BENGT RÅNBY.

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University of Uppsala. Dec 11.

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Action of Penicillin on the Rate of Fall in Numbers of Bacteria *in vivo*

DURING work on the use of penicillin pastilles in oral infections, of which a preliminary report has been published¹, numerous experiments have been undertaken in order to determine the total and differential fall in numbers of different species of bacteria in the mouth and the rate of this fall, under the influence of penicillin. This rate of fall is of particular interest, and as it appears that certain deductions on the mode of action of penicillin can be drawn from the experiments, it is considered that it

is worth directing attention to them in a separate publication. The technique of determining the rate of fall was as follows.

0.1 c.c. of saliva was added to a measured quantity of normal saline 1/50 c.c. of this mixture was then inoculated on to a blood agar plate. This was incubated at 37°C for twenty-four hours, when the number of colonies was counted. From this figure the approximate number of bacteria per c.c. of saliva was calculated.

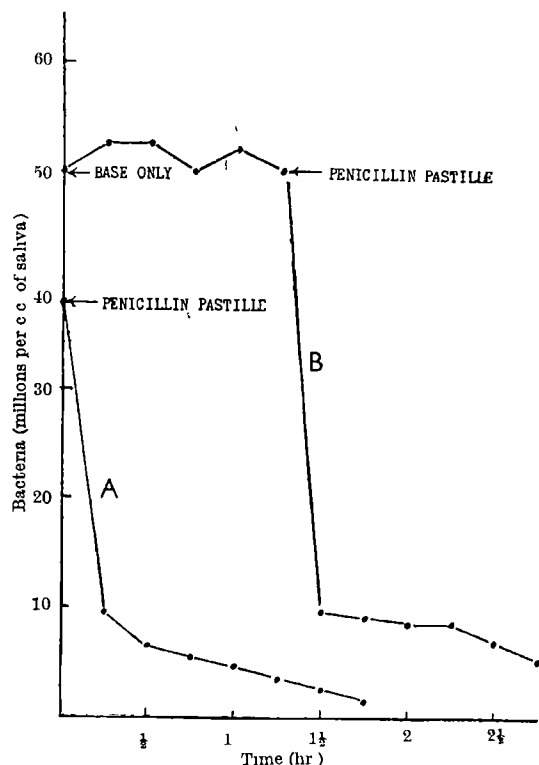
Immediately the first specimen of saliva had been obtained, a 500-unit penicillin pastille was placed in the buccal sulcus between the cheek and the teeth, and allowed to dissolve without sucking. A fresh pastille was inserted every thirty minutes. At fifteen-minute intervals further specimens were taken, and the number of bacteria later estimated in the manner described.

In these experiments saliva diluted with normal saline was used as the inoculum; it was therefore possible that the penicillin present in the saliva and transferred to the plate might be sufficient to inhibit growth. To guard against this action penicillinase was added to the medium.

The results of these experiments are shown in graph A, which represents the mean of three, though the findings have been constant in a far larger series of experiments using pastilles of different strengths.

It will be seen from this graph that the maximum fall in the total number of organisms occurred within the first fifteen minutes after the application of the penicillin.

Increased salivation due to the presence of a pastille in the mouth could have been a factor in this rapid fall, and in order to exclude this possibility the experiments were repeated using pastilles made of base alone, without penicillin. Pastilles of this type were maintained in the mouth for one and a half hours, and estimations on the total number of organ-



isms in the saliva carried out as in the previous experiments

At one and a half hours, pastilles of the same base, but containing 500 units of penicillin each, were inserted and maintained for an equal period of time. The results expressed in graph *B* show that the pastille base alone produced no reduction in the total number of organisms, but substitution of the pastilles containing penicillin caused a fall in numbers comparable with the results shown in graph *A*. The possibility of the mechanical effect of salivation causing a reduction in numbers of organisms could therefore be excluded.

Consideration of the results shows that the most rapid fall in the total number of bacteria occurred in the first fifteen minutes after application of the penicillin. This rapidity of action is difficult to explain on the current hypothesis that penicillin is bacteriostatic, and would suggest that *in vivo*, when conditions of temperature, etc., are favourable, it may have a true bactericidal action.

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¹ MacGregor and Long, *Brit Med J*, ii, 686 (1944)

Action of Notatin on the Rous No. 1 Sarcoma Virus

As notatin exerts its antibiotic activity by virtue of the hydrogen peroxide produced by its oxidation of glucose to gluconic acid¹, it seemed worth while to try the action of this material upon the Rous No. 1 sarcoma, the causative virus of which is readily destroyed by oxidation².

A specimen of notatin, active at 1 in 500,000,000 against *Staph aureus* when last assayed, was generously provided by Dr J. H. Birkinshaw. It was found that 0.2 mgm of notatin, added with 2 mgm glucose to 0.5 ml of a suspension containing 1,000 minimal infective doses of Rous No. 1 sarcoma virus partially purified according to the method of Amies and Carr³, resulted in almost complete loss of activity of the virus in 1½ hours, in two separate experiments. Notatin alone caused a slight reduction in the activity of similar suspensions, while glucose alone had no effect.

In contrast to the activity of notatin *in vitro*, it was found to have no action upon the virus *in vivo*. Amounts ranging from 2 mgm to 5 mgm were inoculated into one tumour of six fowls bearing three or four Rous No. 1 sarcomas in various sites, but it was found that all tumours continued to grow, and the size of the treated tumour relative to the others was not decreased. Doses of 8–10 mgm were fatal to the nine-week-old Brown Leghorns employed. Similarly, pre-treatment of fowls with notatin failed to influence the tumour-producing action of sarcoma virus injected shortly afterwards. Two groups of three birds were injected with either 2 mgm or 5 mgm of notatin into the left breast, and 1½ hours later each breast was inoculated with about 200 infective doses of sarcoma virus, and the legs with about 10 infective doses. No difference in size was found between the sarcomas produced in the notatin-

treated breast and those induced in the untreated side, and the small dose injected into the legs produced tumours in all birds, indicating that a systematic reduction in infectivity of all virus injected in notatin-treated birds had not occurred.

All expenses in connexion with this work were borne by the British Empire Cancer Campaign.

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Dec 14

¹ Schales, O, *Arch Biochem*, 2, 487 (1943)

² Gye, W. E., and Purdy, W. J., *Brit J Exp Path*, 11, 282 (1933)

³ Amies, C. R., and Carr, J. G., *J Path Bact*, 49, 497 (1939)

Thromboplastic Activity of Placenta Extract

In the course of an investigation of hormones of human placenta, we came across a substance which showed strong blood-coagulating properties. Fresh water extracts of placenta contain this factor. The activity diminishes when they are kept at room temperature or in a refrigerator. It is not removed from the extracts by dialysis at 0° C. On filtration through a Seitz filter, the active substance remains on the asbestos fibre. By extracting the filter with distilled water or saline, we obtained a solution possessing the properties of thromboplastin. The resulting slightly opalescent solution is more stable and can be stored for at least one month in a sealed container in a refrigerator without loss of potency. It gives a weak positive reaction with sulphosalicylic acid.

It is of interest that our preparation does not lose its thromboplastic activity when heated for five minutes on a boiling-water bath. This activity manifested on recalcified oxalated plasma (prothrombin time test¹) as well as on fresh whole human blood. The above holds true only for tests carried out with fresh plasma. With plasma stored for some days in the refrigerator a different result is obtained. As is well known, the prothrombin time test depends on the age of the plasma, being prolonged as the plasma is stored. Our placenta extract, which shows this phenomenon. Towards stored plasma the boiled extracts become totally inactive (see table). Thus both our unheated and heated preparations show typical differences in behaviour towards fresh and aged plasma respectively.

EFFECT OF BOILED AND UNBOILED THROMBOPLASTIN ON THE 'PROTHROMBIN TIME' OF FRESH AND STORED PLASMA

Age of plasma	Prothrombin time	
	Unboiled thromboplastin	Boiled thromboplastin
1 hour	12 sec	12 sec
1 "	13 "	13 "
1 "	15 "	18 "
2 days	18 "	23 "
3 "	21 "	28 "
7 "	42 "	185 "
28 "	70 "	more than 10 min

¹ Prothrombin time is the clotting time of 0.1 cc oxalated plasma mixed with 0.1 cc thromboplastin and 0.1 cc 0.02 *M* calcium chloride at 37° C.

Extraction of ox lungs and brain has yielded a substance with similar properties, but preparation from placenta is technically easier. (Recent Reichel² reported a thermostable blood-coagulating

substance from placenta, using a different method of preparation. Because of war conditions, I have not been able to secure a copy of this paper.)

Quick³ has shown that prothrombin is composed of two components, A and B, the former of which disappears when blood is stored. This observation offers a possible explanation of our findings. It is assumed that our thromboplastic substance, too, is composed of two parts, one of them thermostable and acting on component A but not on component B of prothrombin. From stored plasma component A is lost. For this reason the boiled thromboplastin does not act on such plasma.

A full report will be published elsewhere.

My thanks are due to Prof. B. Zondek for suggesting this work and for the interest taken in its progress, and to Drs. Bromberg and Polishuk for their kind help.

The work was aided by a grant from the Rockefeller Foundation.

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Quick, A. J., *Amer. J. Clin. Path.*, **10**, 220 (1940).

Reichel, C., *Klin. Wochschr.*, **21**, 862 (1942); *Chem. Abstr.*, **38**, 2669 (1944).

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Inhibition of Bone Calcification by Sulphonamides

THE recent demonstration by Golding and Silver¹ that certain sulphonamides act as inhibitors of phosphatase *in vitro* has led us to present a preliminary report of our investigations on the effect of sulphonamides on bone formation *in vivo*.

These experiments were designed to test a hypothesis which arose from the findings of Benesch *et al.*² that sulphonamides with a free $-SO_2NH_2$ group (for example, sulphanilamide) inhibit shell formation in the domestic fowl, whereas sulphonamides in which the $-SO_2NH_2$ is substituted (for example, sulphapyridine) do not. The former type of compound is a powerful inhibitor of carbonic anhydrase, while the substituted type does not have any effect on this enzyme, as was shown by Keilin and Mann³.

It was therefore concluded that carbonic anhydrase is active in shell formation by catalysing the rate of formation of the carbonate anion of the calcium carbonate shell material.

Since bone also contains considerable quantities of carbonate, it was thought that carbonic anhydrase, in addition to phosphatase, may play a part in bone formation. In order to test this hypothesis, the calcification mechanism had to be sel-

ected which, like shell-formation, would be rapid enough to reveal the influence of sulphonamide levels compatible with life on the rate of calcification. It was therefore decided to use the calcification of the developing embryo for this purpose.

Pregnant mice and rats were used in these experiments. The mice were divided into two groups which received sulphanilamide and sulphapyridine respectively in doses of 300 mgm./kgm. a day. The drugs were given *per os* in three equal doses daily during the last 7-10 days of the gestation period. The rats were similarly treated with 720 mgm./kgm. a day. Both histological and radiological examinations of the foetuses at term were made to study the effect of this treatment on the skeletal development.

The outstanding histological difference between the foetuses from the sulphonamide-treated rats and normal foetuses from comparable litters was the almost complete absence of calcification, as judged by the haematoxylin staining of the decalcified knee joints (Figs. 1-3). These results must, however, be interpreted in the light of Cameron's observation⁴ that "haematoxylin does not stain calcium salts, though it often identifies areas in which changes favourable to the deposition of calcium salts are taking place". The differences in the mice were equivocal, probably owing to the slight development of the skeleton at this stage, as well as to the lower dosage administered.

X-ray examinations of the sulphonamide-treated rat foetuses revealed striking defects in various parts of the skeleton. These were most pronounced in the skull, the parietal bones of which appeared quite translucent.

It is obvious that the observed impairment of calcification cannot be interpreted as an inhibition of carbonic anhydrase alone, since both sulphanilamide and sulphapyridine had the same qualitative effect. Despite the demonstration by Ercoli and Ravazzoni⁵ that the activity of phosphatase from rice bran and from *Aspergillus oryzae* is not noticeably influenced by sulphanilamide, Blum's observation⁶ that certain sulphonamides inhibit bone phosphatase suggested that the effect may have been due to phosphatase inhibition. The confirmatory demonstration by Golding and Silver that both sulphanilamide and sulphapyridine inhibit bone phosphatase *in vitro* makes this interpretation more likely. It is, however,

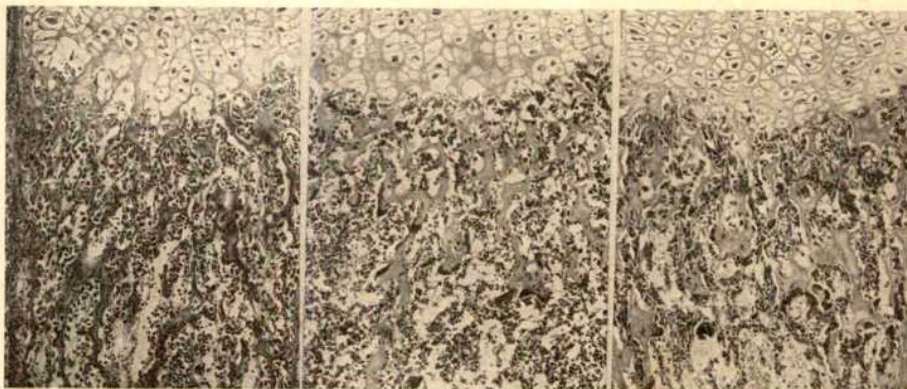


Fig. 1.

Fig. 2.

Fig. 3.

LONGITUDINAL SECTIONS OF LOWER END OF FEMUR OF FETUS FROM (1) CONTROL RAT SHOWING BASOPHIL STAINING OF THE BONE TRABECULAE; (2) SULPHANILAMIDE-TREATED MOTHER, SHOWING ABSENCE OF BASOPHIL STAINING OF THE BONE TRABECULAE; (3) SULPHAPYRIDINE-TREATED MOTHER, SHOWING ABSENCE OF BASOPHIL STAINING OF BONE TRABECULAE. HÆMATOXYLIN AND EOSIN. $\times 75$.

still possible that in the case of sulphonamides with a free $-SO_2NH_2$ group, carbonic anhydrase inhibition may have been masked by the concurrent phosphatase inhibition.

In conclusion, it is pertinent to point out that whereas the dosage used in our experiments was about seven times the therapeutic one, the resulting blood-levels would, however, be still very much lower than the concentration used by Golding and Silver to demonstrate gross phosphatase inhibition *in vitro*.

Further work is in progress on the lines discussed in this communication.

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¹ Golding and Silver, demonstration to the Physiological Society, November 25, 1944.

² Benesch, R., Mawson, C. A., and Barron, N. S., *Nature*, **153**, 138 (1944).

³ Keilin, D., and Mann, T., *Nature*, **146**, 164 (1941).

⁴ Cameron, G. R., *J. Path. Bact.*, **33**, 929 (1930).

⁵ Ercoli, A., and Ravazzoni, C., *Rend. Ist. Lombardo Sci., Classe Sci. Mat. Nat.*, **73**, 573 (1939-40). Quoted from *Chem. Abstr.*, **37**, 3110 (1943).

⁶ Blum, G., *Lancet*, ii, 75 (1944).

Insecticidal Sprays and Flying Insects

It has already been reported that insects are comparatively little affected if they remain motionless in an insecticidal spray of droplet size less than 10 microns in diameter¹. However, when they fly

do not spread either on the wings or on the body surface (Fig. 2). Now a few droplets can be seen on the antennae, mouth parts, eyes, halteres and spiracular guard hairs, and the house-fly also collects very many on the ventral side of the abdomen. It remains true to say, however, that by far the largest number of droplets is collected on the wings.

It is not difficult to demonstrate the insecticidal importance of the spray collected on the wings. When the wings of both *Aedes* and *Musca* are removed just after exposure to an oil spray mist, the kill recorded twenty-four hours later is reduced by about 50 per cent in comparison with an unoperated control group.

As is well known, insects use their legs to clean their heads, antennae and wings; and it is, therefore not surprising to find that droplets which have impacted on these parts are later removed and collected in the first place on the legs (Fig. 3). From the leg the spray may be transferred to the substratum on which the insect is standing, as in the case of the fore legs of the house-fly, it may be cleaned off by the proboscis.

Insects which are being exposed to a spray mist commence the cleaning process as soon as an appreciable number of droplets has been collected. As a result, streaks of dyed spray are deposited from the legs and can be seen on the walls of the cage in which the insects are being exposed. In this way much of the spray collected by an insect during flight will be removed and lost to the surroundings. During the process of removal, however, it will be passed over the legs, which in certain cases are known to be favourable sites for the entry of insecticide. The material removed by the proboscis passes through the gut and is apparent there and in the excreta. There is, therefore, the possibility that material collected on the head and its appendages may ultimately act as a stomach poison.

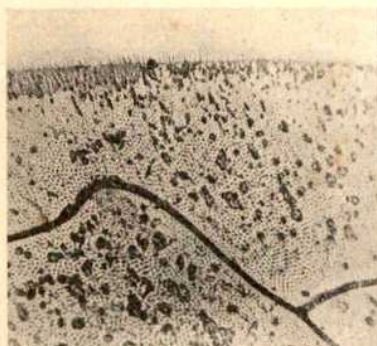


Fig. 1. OIL DROPLETS HELD BETWEEN THE MICROTRICHIA ON THE WINGS OF *Musca domestica*. THEY WERE ACCUMULATED DURING FLIGHT THROUGH AN INSECTICIDAL MIST.

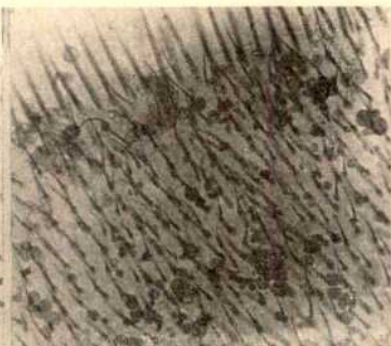


Fig. 2. DROPLETS OF AN AQUEOUS SPRAY ON THE WING OF *Musca* COLLECTED DURING FLIGHT. NOTE THE SPHERICAL FORM IN CONTRAST WITH THE OIL DROPLETS OF FIG. 1.

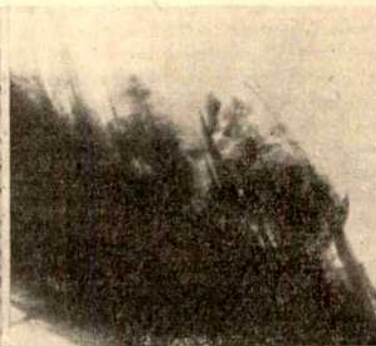


Fig. 3. DROPLETS SHOWN IN FIG. 2 NOW ENTANGLED IN THE BRISTLES ON THE FIRST TARSAL JOINT OF THE HIND LEG OF *Musca*. THESE DROPLETS HAVE BEEN COMBED FROM THE WING.

through such a mist, the insects collect a very large number of droplets on their wings. This observation has been shown to be true in the case of *Aedes aegypti*, *Musca domestica* and *Drosophila* spp. which have been exposed to both oil and water sprays.

The oil droplets which are collected by the wings do not spread since they are held by the microtrichia (Fig. 1), but on the rest of the body small droplets, applied directly, spread quickly. When the spray consists of a dyed dilute aqueous gum solution the situation is rather different, since the droplets

These observations are being extended, and it is hoped to publish a more detailed account at a later date.

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¹ David and Bracey, *Nature*, **153**, 594 (1944).

A Third Factor for Resistance to *Puccinia graminis Tritici*

WE have recently found a third factor for resistance to *Puccinia graminis Tritici* race 34 present in the Kenya varieties of *Triticum vulgare*, and it is considered that a short statement concerning this would be of interest.

In Australia, varieties of *Triticum vulgare* from Kenya Colony, East Africa, have been used widely as a source of resistance to *P. graminis Tritici*. Three strains, Kenya 743, 744 and 745, have been utilized for this purpose. Kenya 743 (C 6040) is a parent of the commercial variety Eureka developed by the New South Wales Department of Agriculture. Several new rust-resistant lines developed at this University owe their resistance to Kenya 745 (C 6042). Kenya 744 (C 6041) was used by wheat breeders in Western Australia since it is also resistant to race 95 of '*triticea*', which occurs commonly in that State. Although we have used this latter variety, no promising lines have resulted from it.

Varieties of wheat from Kenya Colony have been investigated on the North American continent, and in Canada they have been found to be practically immune to many physiological races of stem rust under some conditions¹. Since their resistance is much reduced by increasing temperatures they have not proved popular in the spring wheat areas. The effect of high temperatures, 75–80° F., on the rust infection of seedlings has also been observed here in the glasshouse but it has never been important on adult plants in the field.

In New South Wales the standard race 34 of *P. graminis Tritici* formed the bulk of the stem rust inoculum until 1941, and all the above varieties were highly resistant to it. Genetical studies have shown that the resistance of each variety is apparently governed by a single major factor. Studies on F_2 lines have shown that in 744 the factor is the same as that previously recorded for resistance to races 17, 36 and 6 and the one in 745 is K_1 , these factors being inherited independently². These two factors are not allelic with the one present in Kenya 743, because when this variety was crossed with 744 and 745 in turn and F_2 seedlings were tested with the standard race 34, it was found that approximately fifteen were resistant and one was susceptible. Although a new rust capable of attacking Kenya 743 has recently turned up in Australia, 744 and 745 remain quite resistant to it. In these latter two varieties it seems that the same gene gives resistance to both the new and the old rusts.

Other varieties which were known to possess a single major gene for resistance to the standard race 34 have been crossed in turn with each of the above three varieties, and on the basis of the segregations

of F_2 and F_3 seedlings their relationship to them was determined. So far, Kenya 744 is alone in one group but the other two groups are well represented. All varieties which fall into the group with 743 are susceptible to the new rust which attacks this variety, and at the University of Sydney they are all later in maturity than Kenya 745. Included in the 745 group are varieties of *Triticum vulgare* which have a single factor for resistance and which have derived it from Gaza (*T. durum*).

While there is clear evidence for the existence of these three independent genes no attempt has been made to allocate symbols to them, since this is at present being undertaken by the committee considering nomenclature of wheat genes.

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¹Peterson, R. F., Johnson, T., and Newton, M., *Science*, **91**, 313 (1940).

²Watson, I. A., *Proc. Linn. Soc. N.S.W.*, **68**, 72 (1943).

Nutrients in Wheat Endosperm

RECENT work¹⁻⁴ has added considerably to our knowledge of the distribution of nutrients, particularly the B vitamins, in the wheat grain. The scutellum portion of the germ is the main deposit of vitamin B₁, while the bran is rich in nicotinic acid and iron. Riboflavin is more uniformly distributed throughout the grain, although the highest concentrations are found in the germ. Further work has now shown that the endosperm, far from being uniform in composition, has a complex and graded structure.

The endosperm of wheat is bounded by the aleurone layer which is reputedly rich in protein and minerals. In normal milling, however, this aleurone layer, together with an appreciable amount of 'starchy' endosperm, remains firmly attached to the bran. It has long been known that the concentrations of protein and ash increase from the centre to the outer part of the endosperm adjoining the bran or seed coat; Cobb⁵, for example, found with one sample of wheat that the protein in the central endosperm averaged 7.4 per cent against 16.5 per cent near the periphery. Binnington and Andrews⁶ have also obtained evidence showing that the endosperm adjacent to the bran is much richer in vitamin E than the endosperm contained in patent flour. It has now been found that there are similar gradients for other nutrients. In one experiment a mixture of English wheats was milled on the laboratory plant to produce a short patent flour. The coarse bran was then freed so far as possible from adhering endosperm by four successive passages through a pair of fluted rolls. These four fractions (sieved finally through a 14 silk

Factor	Endosperm fractions (corrected for bran contamination)				Cleaned bran	Whole wheat	Patent flour
	1st	2nd	3rd	4th			
Fibre (per cent)	—	—	—	—	11.5	2.0	—
Ash (per cent)	2.1	3.9	5.9	7.7	6.54	1.49	0.39
Protein (per cent)	13.6	14.3	15.6	16.2	11.4	8.9	8.1
Iron (mgm./100 gm.)	6.4	11.3	16.0	21.4	12.4	2.95	0.54
Total P (mgm./100 gm.)	490	937	1440	1850	1494	311	59
Phytate P (mgm./100 gm.)	371	805	1245	1593	1280	213	<10
Phytate P/total P	0.78	0.86	0.86	0.88	0.86	0.68	<0.17
B ₁ (IU/gm.)	1.4	1.8	2.1	2.3	1.6	1.03	0.13
Riboflavin (μgm./gm.)	1.9	1.5	1.7	2.0	5.0	1.55	0.4
Nicotinic acid (μgm./gm.)	77	148	240	393	250	42	5
Theoretical per cent by weight of wheat	0.89	0.39	0.34	0.43	12.5	100	11

aperture 0.095 mm) together with the residual coarse-cleaned bran were carefully analysed. From the fibre contents of the fractions it was possible to calculate the amount of powdered bran in each fraction and in turn to arrive at the approximate composition of the pure endosperm in each fraction. Certain of the results, together with those for the cleaned bran, the whole wheat and the patent flour (roughly typical of the central endosperm), are given in the accompanying table.

From the method of preparation it would be expected that the fractions contained increasing amounts of aleurone cell contents, but in general the analyses are typical of the starchy endosperm adjoining the aleurone layer. Other experiments, however, indicate that the slopes of the gradients in the endosperm, certainly that for protein, vary in different samples of wheat.

Four points stand out from these results: (1) the outer endosperm is particularly rich in protein, iron, nicotinic acid and phosphorus, (2) the B₁ content, although much higher than in patent flour, is low compared with that in the scutellum where it averages 60 i.u./gm., (3) the bulk of the phosphorus is in the form of phytate P (this incidentally is also true of germ¹ and aleurone layer²), (4) the total weight of endosperm included in the four fractions was approximately 2 per cent of the weight of the wheat, corresponding to a thickness of about 12 μ . Analyses showed that the coarse bran after cleaning still had its aleurone layer practically intact and contained in addition about 5 per cent starchy endosperm (thickness approximately 3.5 μ).

This work is part of a general investigation on the detailed chemistry of the wheat grain and the biophysics of flour milling.

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¹ Hinton, J. J. C., *J. Soc. Chem. Ind.*, 61, 143 (1942), *Biochem. J.*, 38, 214 (1944).

² Barton-Wright, E. C., and Booth, R. G., *Biochem. J.*, 37, 25 (1943).

³ Barton-Wright, E. C., *Biochem. J.*, 38, 314 (1944).

⁴ Kent, N. L., Simpson, A. G., Jones, C. R., and Moran, T., "High Vitamin Flour" (Ministry of Food, October 1944).

⁵ Cobb, N. A., *Dept. Agr. N. S. Wales Misc. Pub.* 539 (1905).

⁶ *Cereal Chem.*, 18, 678 (1941).

⁷ Pringle, W. J. S., unpublished work.

Sources of London Honey

It is well known that the main nectar flow in the London area comes from the limes (*Tilia* spp.) and to a lesser extent from the privet (*Ligustrum*). In some seasons privet predominates and the resulting honey is dark in colour with a slight greenish cast and has an unpleasant flavour with a bitter after-taste. The honeys that were the subject of my note¹ could not be mistaken for privet honey. The colour of the *Ailanthus* honey is a pale amber with a more definite green tinge than any other honey I have seen. Mr. Farmiloe² has evidently misunderstood my description of the flavour. It is quite distinct from that of privet honey, which does not develop the muscatel flavour. The cat-like odour referred to is that of tom-cat urine and differs from both *Ribes nigra* leaves and the musky smell of mice. The odour of *Ailanthus* flowers is strong and similar to that of fresh elder flowers (*Sambucus nigra*), which changes when they wilt to the tom-cat odour. The odour

of *Ailanthus* leaves is different from that of either fresh or wilted elder flowers, but it is irrelevant to this discussion. Another point confirming *Ailanthus* as the source of the cat-like and muscatel flavours is that there was no marked difference of flavour between the two honeys, although in 1944 there was nearly five times as much privet pollen present as in 1943.

That the proportions of pollen species found in a honey do not represent exactly the relative amounts of nectar obtained from the source plants is appreciated full well by palynologists—to use the term recently proposed by Hyde³. Many factors contribute to this lack of correlation in addition to the peculiarities of the bee's honey sack quoted by Mr. Farmiloe. To take an extreme case, no pollen can be gathered from the garden catmint, *Nepeta Mussini*, so beloved of the bees, as the plant has sterile anthers. Generally, however, the pollen content of a honey is a good indication of the botanical sources of the nectars from which it was derived. Thus in a honey pronounced by a well-known honey judge to be one of the best samples of raspberry honey he had seen, 79 per cent of the pollen came from raspberry. Pollen from another honey reputed to be from fruit trees consisted of 68 per cent of fruit tree pollens, more than 50 per cent being apple. Other constituents in this were horse-chestnut 10 and *Tilia* 1 per cent. These particular analyses probably indicate fairly closely the composition of the honeys. On the other hand, dioecious trees like *Ailanthus* will tend to be under-represented as the female flowers have no pollen. Sweet-chestnut, *Castanea sativa*, on account of its abundant and fully exposed pollen, will tend to be over-represented in a mixed honey containing lime, privet and other plants flowering at the same time. Floral morphology and relative abundance of pollen must both be important factors affecting the amount of pollen finding its way into the honey.

It has been my experience that the preconceived ideas of beekeepers as to the floral sources of their honeys are frequently at fault. All the evidence I have gathered suggests that the pollen content is a very useful, though not yet quantitative, indication of origin, and reflects more or less faithfully the history of the bees' labours. For example, the presence of the lime and horse-chestnut pollens in the fruit tree honey mentioned above was explained on inquiring into the history of the hive. The beekeeper had been too busy to extract the honey and had left the supers on the hive until she noticed the first open flowers on the limes. Evidently the bees had already found the lime and had previously worked the horse-chestnut. This honey also shows the working of two separate nectar flows, a feature in evidence in the analysis quoted by Mr. Farmiloe. The most unusual feature of his honey is the high proportion, 27 per cent, of monocotyledonous pollen, for there can be few places in London where such a result is possible.

Exception must be taken to some of the statements quoted from Mr. Yate Allen. The limes produce pollen in fair abundance and moderate amounts are carried back to the hive. The amount of pollen produced bears little or no relationship to the orientation of the flowers. Although anemophilous and nectarless flowers are worked, when the demands of the brood require it, not much pollen of this kind finds its way into the honey. In normal circumstances the bulk goes directly into the brood nest.

While it may be agreed that chemical methods of identification and quantitative estimation of the

botanical sources of honeys are desirable, the chemist has yet a long way to go before he can analyse a 5 gm sample of honey and state with an error of ± 5 per cent the percentage composition in, say, a mixture of horse-chestnut, sweet-chestnut, lime and privet. The mere identification of a readily recognizable substance such as methylanthranilate is but a beginning. Such a goal is probably more nearly within reach of the palynologist.

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¹ Melville, R., *Nature*, 154, 640 (1944)

² Farmiloe, C., *Nature*, 153, 80 (1945)

³ Hyde, H. A., *Museums J.*, 44, 145 (1944)

Duration of the Larval Stage of *Echinometra*

By adding every day a small quantity of food to cultures of *Echinometra* larvæ, Onoda¹ was able to grow them to full larval shape in forty days from fertilization. Mortensen² succeeded in growing larvæ of the same species to metamorphosis in eighteen days. He transferred the larvæ every day, by means of a pipette, to fresh sea-water, thus giving them access of their natural food. Using Mortensen's method, but transferring the larvæ to fresh sea-water twice a day, I have been able to grow them to metamorphosis in twelve days only. Attempts are being made to rear these and other larvæ in order to find the minimum duration of the larval stage, the results will be published elsewhere.

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Onoda, K., *Jap J Zool.*, 8 (1936)

Mortensen, Th., *Mem Acad Sci Copenhagen*, ix, 4 (1937).

Preparation of Stable Colloidal Solutions of Carcinogenic and other Water- Insoluble Compounds

E. BOYLAND¹ prepared colloidal solutions of 2, 5, 6 dibenzanthracene by using acetone as a solvent with the addition of a gelatine solution. Following Berenblum's technique² by using pyridine as a solvent with the addition of a solution of gum arabic, P. H. O'Hara and J. A. Polla³ succeeded in preparing colloidal solutions of low concentration of carcinogenic hydrocarbons. N. Waterman⁴ prepared colloidal solution using acetone-water dispersions of carcinogenic hydrocarbons. The acetone was evaporated in vacuum. M. Wolman⁵ obtained a colloidal solution by the dispersion of acetone solutions of carcinogenic hydrocarbons in water; the acetone was vaporated in large Petri dishes exposed at room temperature.

As neither of these methods, nor the evaporation of the organic solvent on a water-bath, was practical or convenient for our purpose⁶, the following procedure was adopted.

The water-insoluble compounds are dissolved in a small volume of acetone, in a test-tube, and added drop by drop with continued stirring in a given volume of distilled water, depending on the required concentration. The test-tube is washed out with

another small volume of acetone and this also added to the water. The colloidal solution is then freed from acetone by dialysing against distilled water for 2-3 hours as follows. The colloidal acetone-water mixture is poured into a 'Cellophane' bag, the mouth of which is securely fastened about a glass tube. The bag with its protruding glass tube is suspended in a beaker into which distilled water was introduced, allowing the diffusion of the acetone from the mixture into the water. Within 2-3 hours the mixture is freed from acetone. If the water is changed two or three times the period of diffusion may be reduced. The acetone-free colloidal solution is then brought to the desired volume according to the concentration required.

In this simple way we have succeeded in preparing stable and perfect colloidal solutions of any desired concentration (in our experiments we could prepare solution of more than 1 per cent concentration) of almost all carcinogenic and other related and unrelated compounds such as 1, 2, 5, 6 dibenzanthracene, 3:4 benzpyrene, methylcholanthrene, anthracene, pyrene, phenanthrene, cholic acid, desoxycholic acid, cholesterol, oestrone, ergosterol, etc.

We have still to test this method for other water-soluble solvents.

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¹ Boyland, E., *Lancet*, ii, 1108 (1932)

² Berenblum, J., *Lancet*, ii, 1107 (1932)

³ O'Hara, P. H., and Polla, J. A., *Amer J Cancer*, 31, 493 (1937)

⁴ Waterman, N., *Internat Kong Krebsforsch.*, 2, Reference 233 (1937) Bruxelles

⁵ Wolman, M., *Nature*, 145, 592 (1940)

⁶ Feigenbaum, J., *Exper Med and Surgery (U S A)*, in the press

Commutation of Annual Subscriptions

MR J. H. UNNA, in *Nature* of December 9, makes the point that it almost always pays members of scientific and professional institutions who are 'good lives' to commute their annual subscriptions. The great practical objection to this is that a member who commutes is no longer able to make his disapproval felt by resigning. On the contrary, his resignation puts money into the institution's pocket.

It is not difficult to imagine circumstances in which the control of an institution might pass into the hands of a minority, or in which the country and foreign members might object to a policy decided by those who happen to live near London. Foreign members in particular are often disenfranchised entirely, even when questionnaires or voting papers are circulated to all members, since the closing date is usually such that foreign replies arrive too late.

In any such circumstances a dissatisfied member, so long as he pays an annual subscription, can in the last resort exert pressure of a practical kind by withdrawing. This real power should not lightly be forfeited. The professional 'man in the street' may finally have to apply economic sanctions to the scientific and professional institutions in order to force those measures of rationalization which, as the editorial in *Nature* of December 9 points out, have been so long delayed.

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RESEARCH ITEMS

Mould Inhibition of the Tubercle Bacillus

It is well known that Sir Alexander Fleming discovered penicillin because a mould accidentally contaminated one of his plate cultures. Reference is made in the *Lancet* (632, Nov 11, 1944) to the work of D. K. Miller and A. C. Rekate (*Science*, 100, 172, 1944), who found that the growth of a strain of the tubercle bacillus, *Mycobacterium tuberculosis*, was inhibited by a green mould of the *Penicillium* group, which accidentally grew on a culture of the tubercle bacillus stored in an icebox. The mould grew rapidly and well in other cultures of tubercle bacilli at room temperature, but it did not grow at all at 37° C. It grew faster and sporulated earlier on cultures of tubercle bacilli than on sterile media. It also grew in suspensions of human tubercle bacilli in saline at room temperature, and the authors failed to recover the tubercle bacilli from these suspensions later on. Experiments done by inoculation of guinea pigs suggested that some inhibition of growth had occurred, but were less definite. The mould grew well on tuberculin diluted as much as 1 in 10,000, and these dilutions of tuberculin thereafter failed to give positive skin tests in tuberculous guinea pigs. Suspensions of the mould inactivated 1 in 100 tuberculin in 2 hours, and the supernatant fluid obtained by centrifuging such suspensions also did this. When, however, the suspensions were passed through a Seitz filter, they did not inactivate the tuberculin. On the other hand, fluid media on which the mould had grown for 8–15 days had no effect on tuberculin or tubercle bacilli. *Staphylococcus aureus* grew on media on which the mould had grown and from which it had been removed, so that it was concluded that the substance produced by the mould which inhibits tubercle bacilli is not similar to penicillin.

South American Water Mites

An extensive memoir on the water mites (*Hydrachina*) of South Brazil and Paraguay by O. Lundblad is brought to a conclusion by the appearance of the fifth part (*Kungl. Svenska Vetensk. Akad.*, 20, 1944). This consists of 182 pages with 58 text-figures and 10 plates and is of approximately the same size as the other parts which, however, contain more text-figures. The richness of this fauna can be judged from the fact that the present memoir treats of 340 species, sub-species and varieties, and its contribution to our knowledge from the fact that, included in this total, are 282 new species. In spite of this, however, the author considers that the list is by no means complete, for the country has not been so exhaustively covered as some parts of Europe. The summary and conclusions occupy nearly half the present part, with twelve comparative and distributional tables. These include one on all the members of the group that have so far been recorded from South America. The seasonal distribution of the various forms is given, as is also their distribution among three different habitats, standing water, streams and brooks and springs. For the purposes of comparison with other southern hemisphere forms the author takes into consideration the previous work of K. Viets on the *Hydrachina* from the Sunda expedition. There is no doubt that this will form the classical work on South American *Hydrachina* for many years to come.

Lizard Heart

A VERY full account of the lizard heart, as illustrated by that of *Varanus monitor*, the Indian monitor, is given by P. N. Mathur (*Proc. Indian Acad. Sci.*, 20, 1944). A number of new points have been noticed. A suspensory ligament and a sinu-atrial channel are described both atria project for some distance into their respective ventricles and the author terms these the intraventricular portions. The apical region of the ventricle is divided internally into two cavities by a horizontal septum, and these are termed the *cavum apicis dorsale et ventrale*. The author suggests that the septum is not in its entirety the equivalent of the septum ventriculorum of higher forms as assumed by previous writers. It is further suggested that the names *cavum arteriosum* and *cavum venosum*, since they have a functional significance, should be replaced by *cavum dextrum* and *cavum sinistrum*. The bibliography, which is very full, is marred by certain slips that have not been corrected in the proof reading.

Strains of the European Corn Borer in the United States

UNDER the above title, K. D. Arbuthnot, of the U.S. Bureau of Entomology and Plant Quarantine, describes experiments conducted during 1937–40 on the possible occurrence of strains of this insect and their physiological relationships (*Tech. Bull. U.S. Dept. of Agric.*, No. 869, March 1944). It appears that material collected from New Haven, Conn., was found to be of a homozygous multiple-generation strain, and no evidence was obtained to indicate the occurrence of a single-generation strain in that locality. Material from Toledo, Ohio, was heterozygous, a complex of single- and multiple-generation strains occurring together. A homozygous single-generation strain was isolated from Toledo material but it was not found possible to obtain a homozygous multiple-generation strain. Larvae of the single-generation Toledo strain grew more slowly than those of the multiple-generation strain from New Haven. Moths from the Toledo and New Haven field-stocks each showed a preference for mating among individuals from their own locality rather than crossing between the stocks. Mating of New Haven females with Toledo males was obtained in only a few cases, because of a racial inhibition to such mating. From these and other grounds, which are stated in detail, the author concludes that distinct biological strains of the insect in question have been demonstrated by his experiments.

External Factors and Growth of Wheat

AN attempt to assess the precise effects of differences in date and depth of sowing, conditions of spacing and kind of soil has been made by S. S. Lab Singh and Nek Alam (*Proc. Ind. Acad. Sci.*, B, 19, 29, 1944) in a study of one or two varieties of wheat grown in a series of randomized replicated blocks at two different localities. Irrespective of date, time or depth of planting, rate of germination was most rapid from midnight to 8 a.m. and slowest from noon to midnight. The optimum range for depth of sowing was large ($\frac{1}{2}$ –3 $\frac{1}{2}$ in.), deeper sowing being better for earlier planting and light soils needing deeper sowing than heavy ones. Shallow sowing at early dates gave a high seedling mortality. Spacing had no effect on the mortality and was the only factor which did not affect the rate of production of the first four foliage leaves. The main stems grew fastest but reached the shortest final height in late (January).

sown material, and such plants had a lower number (7.8) of fertile spikelets than the October sown plants (20.8). Wider spacing always gave more fertile spikelets. Head development in December material appears to have been at a critical threshold since the ears were long and lax in the more widely spaced material while under closer spacing they were very dense. It is concluded that in order to avoid discarding types which would be valuable introductions when grown under their optimum conditions, new varieties should always be given a very thorough trial under a wide range of conditions.

Root Stock and Scion Relationship

THE problem of root stock and scion relationship in grafted trees is one of interest and economic importance. Optimum growth and development of the grafted tree result only when scion and stock are compatible. Incompatibility generally results either in a failure of the graft to take, or else in reduced growth followed by an early death. E. L. Proebsting and C. J. Hauser (*Proc Amer Soc Hort Sci.*, 42, 270, 1943) describe what may be a case of partial incompatibility between apricot scions and Myrobalan plum root stock. Apricots grafted on to this stock show a leaf scorch consisting of a cupping of the leaves, which are reduced in size and develop a marginal scorch. Excision of the dead tissue follows. The condition is neither cured nor prevented by injection of copper sulphate, boric acid, manganese sulphate, ammonium molybdate, zinc sulphate, thorium nitrate, potassium dichromate, barium chloride, sodium tungstate, cadmium sulphate or cobaltous acetate either alone or in various mixtures and is unlikely therefore to be a deficiency disease. On the other hand, scion rooting reduces the severity of the symptoms and diseased trees marched with apricot seedlings show a recovery.

Kalsilite-bearing Lavas of South-west Uganda

At a meeting of the Royal Society of Edinburgh on December 4, A. D. Combe and Arthur Holmes presented a paper on "The Kalsilite-bearing Lavas of Kaburige and Lyakauli, South-west Uganda." It has been known for half a century that Ruwenzori is flanked by a series of recently extinct volcanic areas, each of which consists of tuffs, explosion craters and rare lava flows. The first systematic survey of these volcanic fields was carried out by Mr Combe during 1933-39, and representative collections, amounting to nearly 1,000 specimens, were sent to Prof Holmes for petrological study. The rocks of this unique petrographic province are highly potassic ultrabasic types of which the chief members are the following:

gandite	=augite+leucite	} with abundant olivine, perovskite and iron ore ± biotite ± glass
afurite	=augite+kalsilite (KAlSi ₃ O ₈)	
atungite	=melilite+leucitic glass	
kalsilite-katungite	=melilite+kalsilite	

The lavas described in the present contribution lie near the eastern edge of the Western Rift Valley, south-east of Kazinga Channel. They are kalsilite-bearing throughout and consist of mafurite and various transitional varieties containing leucite and/or melilite. The tuffs that preceded and followed the lavas are typical of those of the province as a whole and contain (a) fragments of quartzite, phyllite and granite derived from the underlying bedrocks, (b) fragments of cognate sub-volcanic biotite-proxenite and peridotite, and (c) lapilli of atungite. The lavas contain xenoliths of (a) and (b) in all stages of transfusion by magmatic emana-

tions, the most significant change being the transformation of the minerals of granite into leucite and eventually into an assemblage of minerals equivalent to leucite. This discovery throws much new light on the genetic relationships between the various volcanic rocks, all of which can be traced back to the magmas responsible for kalsilite-katungite and mafurite. Twelve new chemical analyses have been contributed by Dr H. F. Harwood and others.

Dielectric Constant and Energy Loss in Solids and Liquids

IN a published paper (*J Inst Elec Eng*, 91, Part I, No 48, Dec 1944), H. Frohlich discusses the theory of the dielectric properties of a large group of solid and liquid organic substances built up of long-chain molecules, from the point of view of modern atomic and molecular structure. It is shown that in such substances dipoles have two equilibrium positions with opposite dipole direction. The static dielectric constant should increase with temperature below a critical temperature and decrease above it. The dielectric power loss for crystalline solids should be approximately described by the Debye equations, but for amorphous substances a flattening-out of the Debye loss curve is expected. For long-chain molecules the dependence of the time of relaxation on chain-length has been calculated, and the relevant equations are given in the paper.

Spectrophotometry of a Wolf-Rayet Binary Star

C. S. BEALS, Dominion Astrophysical Observatory, Victoria, B. C., has discussed the Wolf-Rayet Binary HD 193576, noticed first as a variable by Martin and Plummer in 1917 (*Mon Not Roy Astro Soc*, 104, 4, 1944). Its range of variation at that time was believed to be small, and in 1939 O. C. Wilson announced that it was a spectroscopic binary. Beals undertook a series of spectrographic observations in the summer of 1942. The data consisted of 61 spectra, 39 of which cover the region λ 3900-5000, while 22 are in the region λ 5300-6700. Comparison of line and band intensities with those of typical stars of the same spectral classes led to apparent visual magnitudes of 8.30 for the O-type star and 10.5 for the W companion. The distance of the binary is estimated from the strengths of the interstellar lines, and the value adopted is 1,180 parsecs. On the assumption of an effective temperature of 80,000° for the W-star and 40,000° for the O-star, the radii are 1.3 and 4.2 respectively, the radius of the sun being the unit. A discrepancy between the diameter of the O-star as determined from the light curve and as determined from the absolute magnitude and temperature is explicable on the assumption that the W-star may have a very small radiating core and also an extensive envelope capable of absorbing light from the O-star. Beals's results differ considerably from those of Wilson, who suggested that the origin of the Wolf-Rayet emission bands takes place close to the photosphere, a view which was based on the absence of a transit-time effect. This assumed complete spherical symmetry in the expanding envelope. Beals's interpretation of the spectrum of the binary suggests that tidal effects prevent this condition from being realized even approximately in the envelope of the system. He pictures a shell of ionized helium surrounding the W-star only, the pair being surrounded by a larger shell of neutral helium, the ionized helium shell is distorted by the tidal action of the O-star, the mass of which is $2\frac{1}{2}$ times that of the W-star.

BIPHASIC ACTION OF PENICILLIN AND OTHER SULPHONAMIDE SIMILARITY

By SURG. LIEUT.-COMDR. W. SLOAN MILLER, R.N.,
SURG. COMDR. C. A. GREEN, R.N.V.R.,
and DR. H. KITCHEN
Royal Naval Medical School

SUBSTANCES generally acknowledged as being toxic to cells may have an opposite effect in higher dilution. This biphasic action—inhibition in high concentrations and stimulation in low concentrations—has been observed with a wide variety of substances, including narcotics, cyanide, pyridine¹ and sulphonamides². There is ample evidence that low concentrations of the last group stimulate bacterial growth, and it would appear that the period of active proliferation, which frequently precedes bacteriostasis by sulphonamides in higher concentrations, is a manifestation of the same phenomenon. We here report what appears to be an expression of the same effect occurring with penicillin.

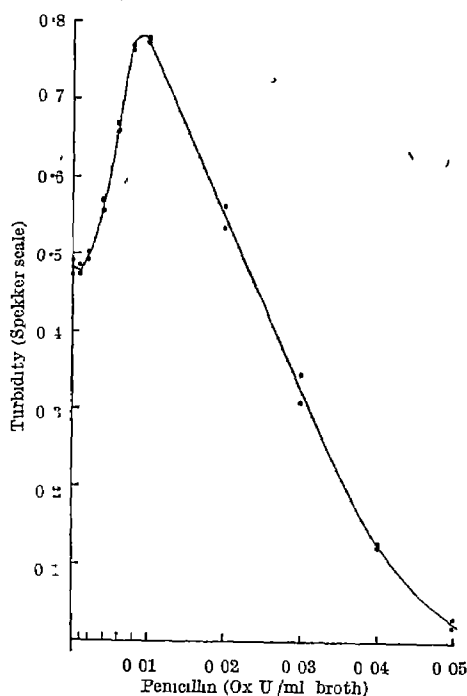
The growth of sensitive bacteria in broth is quantitatively inhibited by suitably graded dilutions of penicillin, and the degree of inhibition can be measured turbidimetrically³. With the Oxford H staphylococcus (No. 6571 N.C.T.C.) as test organism, and measuring turbidity on the logarithmic scale of a Spekker photoelectric absorptiometer, we have obtained turbidity-penicillin concentration curves generally sigmoid in shape, with broth penicillin concentrations from 0.05 Oxford units per ml to 1 ml. Frequently, however, we have observed that tubes containing 0.005 U/ml, and sometimes 0.01 U/ml, have shown significantly more turbidity than those containing no penicillin. This effect appeared inconsistently when the incubation temperature was 37°C. At that temperature it has been noted after 4–24 hours of incubation, with a staphylococcal inoculum of between one and ten million per ml broth, and with different samples of commercial sodium penicillin assaying from 84–820 units per mgm. It occurred in nutrient broth containing 'Marmite' and 0.1 per cent glucose, and in 10 per cent horse serum broth without the addition of sugar. In a preliminary investigation of this phenomenon we have been unable to define the exact conditions necessary for its occurrence at 37°C, but the amount of bacterial inoculum and duration of subsequent incubation are certainly concerned, whereas the pH of the medium, age of inoculum, the order of mixing and initial temperatures of the various reagents in the test, within certain limits, are not critical.

We have been able to study this phenomenon more easily by incubation at temperatures below 37°C. It may be consistently reproduced by overnight (16 hr) incubation at 24°C of 20 ml amounts of nutrient broth containing 'Marmite' and dextrose (0.1 per cent), with an inoculum of approximately 5,000,000 cocci per ml, from a 24-hour broth culture. Under these conditions a well-marked growth-stimulating effect has been repeatedly obtained with penicillin concentrations in the broth of about 0.01 Oxford units per ml, as shown in the accompanying graph from an actual test. The addition of *p*-amino-benzoic acid (5 mgm per 100 ml) to the medium makes no qualitative difference to the result, nor does the addition of 10 per cent horse serum.

The increased turbidity is not due to mere enlarge-

ment or distortion of the individual cocci⁴. The organisms from tubes at the peak of the curve (containing growth-stimulating dilutions of penicillin) are morphologically indistinguishable from those containing no penicillin. In fact, plate counts have provided unequivocal evidence that there may be twice as many viable bacteria in the penicillin growth-stimulated cultures as in controls containing no penicillin. That this observation is caused by impurities seems unlikely in view of consistent reproducibility of the effect with pure crystalline penicillin, significant increases in turbidity over penicillinless controls can be obtained with as little as 0.0006 micrograms per ml.

Apart from recording the participation of penicillin in a rather general biological phenomenon, the object of this communication is to direct attention to the accumulating empirical evidence of the similarity of penicillin and sulphonamide action. So far as we are aware, the only commonly held conception of the mode of action of penicillin is that it acts bacteriostatically by preventing division of growing cells. This is based on Gardner's observation that bacteria subjected to concentrations of penicillin too small to inhibit growth completely undergo distortion and enlargement⁴. Analogous morphological changes are frequently associated with sulphonamide action. It has been further proposed that penicillin acts only on dividing bacteria⁵, and that this action is bactericidal⁶. One of the final conclusions reached by Henry, in a very comprehensive review of the mode of action of sulphonamides, is that they achieve their effect by stopping cell division⁷. In general, the antibacterial action of both penicillin and sulphonamides, *in vitro* and *in vivo*, appears to be primarily 'bacteriostatic'. Under certain experimental conditions, however, penicillin^{8,9}, like sulphonamides, may exert a 'bactericidal' effect. Confusion



TURBIDITY-PENICILLIN CONCENTRATION CURVE
Staphylococcal broth after 16 hr incubation at 24°C. The concentrations lower than 0.01 U/ml are 0.008, 0.006, 0.004, 0.002 and 0.001 U/ml respectively. Test in duplicate.

is caused by drawing too fine a distinction between these terms

The fundamental antibacterial action of penicillin and sulphonamides is inhibition of cell multiplication. Sulphonamides inhibit the growth of almost every variety of cell besides bacteria, although in widely varying concentration, there is as yet little evidence that penicillin will have such a general effect, but Cornman has reported survival of normal cells in penicillin solutions lethal to malignant cells⁹. Sulphonamide action is usually biphasic, our observations suggest that this may be true of penicillin. Primary bacterial proliferation preceding bacteriostasis, as occurs with sulphonamides, has recently been noted with penicillin and *Leptospira icterohaemorrhagiae*¹⁰. (As mentioned previously, this may well be another aspect of the biphasic phenomenon.) Penicillin growth-inhibition, in conformity with that of sulphonamides, appears to obey the law of mass action, in that (a) the inhibition is reversible, by removing the bacteria from contact with penicillin or destroying the penicillin with penicillinase, and (b) the inhibition is directly related to the penicillin concentration³. Both penicillin^{6,8} and sulphonamide activity are directly related to the temperature. In the presence of a constant amount of sulphonamide, antibacterial activity is inversely related to the number of organisms present, this is a phenomenon which awaits satisfactory explanation, and the explanation is also required in respect of penicillin⁶. A feature of sulphonamide activity is that it varies from one bacterial species to another, from strain to strain, and even perhaps from organism to organism. Penicillin exemplifies this selectivity *par excellence*. Antibacterial effect is greatly influenced by the sulphonamide chemical structure, and scientific progress with penicillin must be seriously impeded until its structure is made known. By analogy, however, there is every reason to expect that substances chemically related to penicillin will have different bacterial 'spectra'. Chemical information is also lacking for a comparison of the effect of pH changes on penicillin action, at present this factor appears more important to sulphonamide action. Organisms can be trained to resist either penicillin or sulphonamides to a surprising degree, and with almost equal ease. Penicillin shares with sulphonamides synergism of antibacterial effect by antibodies and cellular defence mechanisms.

The commonly accepted theory of sulphonamide action, that of Woods and Fildes, casts *p*-amino benzoic acid in an essential role¹¹. Since this substance plays no similar part in penicillin action, some fundamental difference in mode of action might be presumed. But Henry's conclusions throw considerable doubt on the Woods-Fildes explanation, and reconcile this apparent anomaly in sulphonamide-penicillin similarity⁷. There appears to be general agreement that sulphonamide bacteriostasis is achieved by direct inhibition of one or more enzymes. The profound biological activity shown by penicillin in trace concentrations would appear to be eminently explicable in terms of enzymic phenomena. It is not our purpose, however, to speculate on the mode of action of penicillin; but to suggest, on the basis of empirical observations available now, that it is not likely to be fundamentally unique. The differences that do exist between sulphonamides and penicillin, and which place the latter in its pre-eminent therapeutic position, appear to be differences of degree so far as mode of action is concerned.

Much of the technical work on which our observations are based was performed by laboratory assistants in the Royal Navy, to whom we are indebted. The crystalline penicillin was generously given by I.C.(P), Ltd.

Addendum Additional information has become available since this communication was written. It is now clear that at least three chemically different varieties of penicillin have already been identified and that their relative efficiencies for various bacteria are probably different¹². The effect of pH on penicillin activity¹³ is, in fact, in striking conformity with what has been reported for sulphonamides. The direct relationship of temperature to penicillin activity has been amplified^{13,14}. Todd¹⁵ has demonstrated the frequency with which primary multiplication occurs in cultures subjected to the influence of penicillin, and noted that Fleming originally reported this phenomenon in 1929.

¹ Woolley, D. W., and White, A. G. C., *J. Expt. Med.*, **78**, 489 (1943).

² Finklestone-Sayless *et al.*, *Lancet*, **ii**, 792 (1937). Green, H. N., *Brit. J. Expt. Path.*, **21**, 38 (1940). Green, H. N., and Bielschowsky, F., *Brit. J. Expt. Path.*, **23**, 1 (1942). Lamanna, C., *Science*, **95**, 304 (1942). Lamanna, C., and Shapiro, I. M., *J. Bact.*, **45**, 385 (1943). Colebrook *et al.*, *Lancet*, **ii**, 1323 (1936). McIntosh, J., and Whitby, E. H., *Lancet*, **ii**, 431 (1939).

³ Foster, J. W., *J. Biol. Chem.*, **144**, 285 (1942). Foster, J. W., and Wilkins, B. L., *J. Bact.*, **43**, 377 (1943). Foster, J. W., and Woodruff, H. B., *J. Bact.*, **46**, 187 (1943). Joslyn, D. A., *Science*, **90**, 21 (1944). Lee *et al.*, *J. Biol. Chem.*, **152**, 485 (1944). McMahan, J. R., *J. Biol. Chem.*, **153**, 249 (1944).

⁴ Gardner, A. D., *Nature*, **140**, 837 (1940).

⁵ Miller, C. P., and Foster, A. Z., *Proc. Soc. Expt. Biol. N.Y.*, **58**, 205 (1944). Hobby, G. L., and Dawson, M. H., *Proc. Soc. Expt. Biol. N.Y.*, **181** (1944).

⁶ Bigger, J. W., *Lancet*, **ii**, 497 (1944).

⁷ Henry, R. J., *Bact. Rev.*, **7**, 175 (1943).

⁸ Garrod, L. P., *Lancet*, **ii**, 673 (1944).

⁹ Cornman, I., *Science*, **99**, 247 (1944).

¹⁰ Alston, J. M., and Broom, J. C., *Brit. Med. J.*, **2**, 718 (1944).

¹¹ Woods, D. D., and Fildes, P., *Chem. and Ind.*, **59**, 133 (1940).

¹² See *Nature*, **154**, 725 (1944).

¹³ Garrod, *Brit. Med. J.*, **1**, 107 (1945).

¹⁴ Eagle and Musselman, *J. Exp. Med.*, **80**, 493 (1944).

¹⁵ *Lancet*, **i**, 74 (1945).

CONFERENCE ON AUDIO-VISUAL EDUCATION

AUDIO-VISUAL education and the part it must play in the schools of Hertfordshire were discussed at a whole-day conference held at Welwyn St. Mary's C.E. School on February 2.

Opening the Conference, Mr. A. R. Chorlton, deputy education officer for the county, who has done much to foster an interest in this aspect of education, commented upon the suitable atmosphere for the subject under discussion created by a set of artist's originals for a series of coloured lithographic posters dealing with the Industrial Revolution, brought for the occasion by Lieut.-Commr. Rawnsley, of Common Ground, Ltd., and the various optical instruments and demonstration material provided by Metalair, Dufay Chromex, and a Hertfordshire school which has been specializing in audio-visual education. The Conference, he said, was the outcome of work done during the past eighteen months by the Watford and District Audio-Visual Education Association and the North Herts Visual Aids Committee. Its object was to enable members of both Committees to meet and discuss a plan of action for the ensuing year.

In the absence of Mr. G. Patrick Meredith, lecturer in visual education, University College, Exeter, who

MANGROVES IN THE NEW WORLD

was to have addressed the meeting, Commander Rawnsley opened the discussion on visual material and media by outlining the objects of experiments he had conducted in this field in order to provide suitable material in the form of background posters, classroom exhibitions, film-strips and films. He stressed the need for integrating means and material in order to produce a living situation, and argued that only thus can a child be truly educated to become a useful member of the community. To do this, teachers will have to become attuned to the visual education approach. The value of Commander Rawnsley's contribution was emphasized by the excellent teaching quality of the film-strip and film on coal, edited under the guidance of J. Fairgrieve, which complemented the exhibition.

The afternoon session was opened by Mr. A. Arkinstall, headmaster of Callow Land Boys' School, Watford. His subject was "Essentials for a Successful Audio-Visual Aids Programme". Commencing with the child—for that, he felt, is where we should start if we are to have ultimate success with any project which concerns the child—he outlined the educational pattern which must be completed if his audio-visual needs are to be met. A better understanding of the dull and backward child's point of view and environment, coupled with an education which has a good audio-visual content, would do much to reduce juvenile delinquency. In the immediate future, we should collect as much information as possible to help to put audio-visual education on a sound psychological basis. The teacher has great opportunities in this connexion. Experiments should be conducted on research lines organized by committees of local associations, and the findings passed on to the university research departments. He envisaged the time when each county would have a central clearing-house in contact on one hand with the B.B.C., Federation of British Industries, museums, Ministry of Education, local education authorities, authors (for copyright permits), university research centres, and producers of audio-visual means and material, and on the other with audio-visual associations, head teachers, training colleges, adult education centres and youth movement leaders.

At the present time schools are ill-equipped for audio-visual education, apparatus such as wireless receivers, film-strip and film projectors, gramophones and records, together with plenty of good pictures in good sequences, all approved by teachers for quality in a teaching situation, are needed for use in rooms suitably equipped for such instructional means. Despite present shortcomings, the best use must be made of such material and means as are available in order to show by the results of one or two pieces of research work that this is a worthwhile project upon which money would be well spent.

This suggestion was followed by Mr. H. Goldsmith, one of the Ministry of Education inspectors, who gave an account of the conditions of loan to the county of a number of American strip-film projectors, each accompanied by fifty strips dealing with various aspects of life in America. He hoped that part of the research proposed would be in connexion with the evaluation of this material.

A particular feature of the Conference was the practical nature of the suggestions put forward by those contributing to the discussions in both sessions, but perhaps this was to be expected when their interest in the apparatus and material which surrounded them on all sides is considered.

MANGROVES have been of interest to botanists ever since the first details were given by morphologists in the eighteenth century, not only to specialists in ecology on account of their somewhat peculiar distribution as shore-line vegetation, but also to the general botanist in view of the unusual morphological and physiological features which they display. It is therefore satisfactory that it has been found possible to give a very full account of the main features of these plants as observed by the 1934 Cambridge Expedition to Jamaica.¹ Those of us who have attempted field experiments even a short distance from the laboratory will realize full well the difficulty in assessing requirements beforehand, and it can well be understood that the performance of the Expedition falls short of its members' expectations on this account and in view of the scanty data already in the literature on which they had to rely for guidance. Nevertheless, in spite of these unavoidable difficulties and notwithstanding the cessation of activity due to the outbreak of war, Dr. Chapman presents a most impressive series of three articles ranging over a wide field of endeavour. It is stimulating to find here a clear grasp of the problems involved in attempting to relate morphological character to physiological function, with repeated emphasis on the problems yet to be solved. Work of this kind can clearly not be final, and probably the most useful feature of the Expedition, as it is reflected in these papers, lies in the guidance it gives for more detailed investigation which may become possible in the future.

The first paper surveys the botanical processes involved in the maintenance and development of the shore-line in Jamaica, and discusses the distribution and ecological significance of the range of mangroves and associated plants found on the island. In the second and third, Dr. Chapman concentrates on one particular species (*Avicennia nitida* Jacq.) from the point of view of its relation to its environment, its morphology, and the physiological peculiarities associated with pneumatophores.

It comes somewhat as a surprise to the uninitiated to realize the comparatively wide tolerance of mangroves to soil conditions. Here we have soils ranging from sand to mud well populated, with salinity of soil water ranging over wide limits even up to fresh water in isolated cases. It is impossible in a short space to consider the vast amount of information presented in any detail, but it may be said in general that the drift in dune development resembles in broad outline that found in the British Isles and that the mangroves of the New World as found in Jamaica come under the 'wide salt tolerance' class into which Schimper put some of the Old World species. Details of species and probable origin are given, and the brief discussion of the migration of seeds and seedlings along ocean currents, and the effects of fresh water at river estuaries, surely forms one of the most fascinating stories in all nature study.

In the second paper an attempt is made to elucidate the edaphic factors important in the growth of the mangrove, which shows optimum growth in soil with more than 0.5 per cent sodium chloride when the water content either does not fall below a certain minimum or is replenished periodically by flooding. Oxygen content is not thought to play any important part in zonation, partly because the root system has

a comparatively thick bark which may be impervious to gases, and the role of sodium chloride is doubtful. It is probable that a number of factors—winter temperature, ocean currents, tidal inundation, soil accretion, mechanical composition of soil, exchangeable base and the behaviour of the water table—are all important collectively. Soil conditions vary over relatively narrow limits. Soil pH varies from about 6 to about 8 over the soil types populated and the water-table fluctuates through only two to three inches. This latter is particularly important, for it means that the horizontal roots and the pneumatophores are above the water-table for considerable periods, and we must abandon the idea that mangrove roots must be bathed in water continually. In the soil water the oxygen content is well below the atmospheric percentage, but carbon dioxide is on the whole higher, and this therefore lends colour to the widely accepted belief in the function of the pneumatophores in aeration. The Na^+ and Cl^- contents of soil water and of plants are presented at some length, but unfortunately the statements made in this part of the paper lose much of their force as the basis upon which the percentages are given is not clearly defined.

The third paper gives a very welcome and admirably thorough description of the developmental morphology of *A. nutida* from the young seedling to the mature plant, profusely illustrated by line drawings in some of which, however, it is not always easy to pick out the details referred to in the text. Secondary thickening appears to varying extents in almost all the organs of the plant, and it is particularly interesting that, so far as one can judge from the data presented, thickening begins in the roots before it does in the stems (though this is not, in fact, specifically stated). The pneumatophores (which are said to be negatively geotropic, but may, as Dr Chapman points out, be positively aerotropic) may be some 35 cm high by about 8–10 mm thick, with well-formed lenticels in the above-ground portion. The cortex has numerous large longitudinal air spaces, as has also the corresponding tissue in the horizontal roots from which the pneumatophores arise, but the two systems are apparently separated by a more solid tissue at the base of the pneumatophores. Movement of gases from pneumatophore to horizontal roots must therefore occur by diffusion and not by mass flow. The gas in these air spaces is very much like that in the atmosphere and very different from that found in the soil water. Experimental work shows that of the carbon dioxide exhaled by a pneumatophore, about 50 per cent may come from the respiration of the pneumatophore itself (a figure which should apparently be in fact much higher, since in the experiments the air spaces in the horizontal roots were replaced by an atmosphere containing 10 per cent carbon dioxide applied to the lower end of the pneumatophore from cylinders prepared in advance in Britain, this carbon dioxide content is much larger than that actually found in the air spaces). The respiratory function of the pneumatophore itself must therefore not be overlooked. Further, as Chapman also emphasizes, the pneumatophores carry absorbing rootlets near the soil surface and as soil accretion occurs, these rootlets appear higher up the pneumatophore and therefore nearer the new soil surface. A further important function of the pneumatophores may therefore be the maintenance of a functional absorbing root system.

Dr. Chapman makes it abundantly clear that

mangroves will repay intensive study by morphologists, physiologists, geneticists, biochemists and even students of cell-wall problems. In this latter regard, some of the cells in pneumatophores bear peculiar internal buttresses growing into the cell from the wall and recalling the trabeculae found in the tracheids of some conifers and similar structures in marine algae like *Caulerpa*. These idioblasts, as they may be called, would repay study. All the papers include a very full bibliography and a careful comparison of the writer's work point by point with that of earlier workers in the field, and this makes them, indeed, a veritable compendium of mangrove lore.

R. D. PRESTON

¹ Chapman, V. J., *J. Linn. Soc.*, 52, No 346 (1944)

EFFECTS OF HEAT ON HUMAN BEINGS

AN interesting series of physiological and clinical observations on the effect of the desert climate of Shaiba, southern Iraq, in the summer of 1943, has been reported by W. S. S. Ladell, J. C. Waterlow and M. F. Hudson (*Lancet*, 491, Oct. 14 and 527, Oct. 21, 1944). Both fit soldiers and cases of the effects of heat were studied. All the fit men lost some weight in the hot weather, especially those who had the highest chloride concentration in their sweat. The measured rate of sweating and the estimated salt intake indicated that subjects with a high concentration of chloride in their sweat (more than 0.3 per cent of sodium chloride) may not always have been in salt balance. Low output of urine, in spite of high water intake, low urinary chloride and raised blood urea, suggested salt-deficiency dehydration.

Twelve cases of hyperpyrexia are recorded and two types of heat exhaustion. The first type occurs, it is suggested, in persons who secrete sweat containing much higher chloride concentrations than the average; their salt intake is insufficient and they become salt-deficient, extra salt might prevent the occurrence of heat exhaustion in these persons. The second type was seen only in the second half of the summer in men unaffected by the heat of the first half; prickly heat accompanied the heat exhaustion, but this type did not have the vomiting and cramps suffered by the first type. The condition of the second type suggested a breakdown of the body's defences against heat. There was salt-deficiency, but no dehydration. It would be worth while to inquire whether the concentration of salt, or of other constituents of the sweat, or the influence of other factors controlling its secretion, could be related in any way to the well-known variations in susceptibility to the bites of mosquitoes and other biting arthropods.

Following this article, D. H. G. MacQuaide describes (*Lancet*, 531, Oct. 21, 1944) two cases of congenital absence of the sweat glands. Both had to be classified as totally unfit for service in the tropics. The author adds an interesting note on the literature relating to congenital ectodermal defects. These include an idrotic group, which is mostly a hair and nail dystrophy found in both sexes and transmitted by either, and an anidrotic group, found mostly in males and probably transmitted by a maternal carrier, in this latter group are absence of the sweat glands and occasionally of the sebaceous glands, dental dysplasia and other conditions of the nose, skin and hair. No cases belonging to this group are known in Negroes or Latin races. G. LAPAGE.

FORTHCOMING EVENTS

Saturday, February 17

INSTITUTE OF PHYSICS (LONDON AND HOME COUNTIES' BRANCH) (at the Royal Institution, Albemarle Street, London, W 1), at 2 30 p.m.—Dr R. E. Slade "The Organisation of Research in Industry"

NORTH OF ENGLAND INSTITUTE OF MINING AND MECHANICAL ENGINEERS (at Neville Hall, Newcastle-upon-Tyne), at 2 30 p.m.—Lieut.-Colonel H. E. B. Daniell and Mr L. H. Forster "Successful Operation of Two-Stage Air-Cooled Inbye-Compressor". Mr R. Williams, Mr W. Jeffery and Mr A. Taylor "Outbursts of Gas from the Floor of Coal Seams, Part 2"

Saturday, February 17—Sunday, February 18

ASSOCIATION OF SCIENTIFIC WORKERS (at Caxton Hall, Westminster, London, S W 1)—Conference on "Science in Peace"

Saturday, February 17

At 2 15 p.m.—"Science and Production" (Chairman Prof P. M. S. Blackett, F.R.S.)

Sunday, February 18

At 10 a.m.—"The Future Development of Science" (Chairman Sir Robert Watson-Watt, F.R.S.)

At 2 30 p.m.—"Science in Everyday Life" (Chairman Prof H. Levy)

Monday, February 19

IRON AND STEEL INSTITUTE (joint meeting with the CLEVELAND INSTITUTE OF ENGINEERS) (at the Cleveland Scientific and Technical Institute, Corporation Road, Middlesbrough), at 6 30 p.m.—Mr G. D. Elliot "Ironmaking at the Appleby-Frodingham Works of the United Steel Companies, Limited"

Tuesday, February 20

ROYAL SOCIETY OF ARTS (DOMINIONS AND COLONIES SECTION) (at John Adam Street, Adelphi, London, W C 2), at 1 45 p.m.—Sir Edmund O. Teale "The Contribution of Geological Survey to the Development of the Mineral and other Resources of East and West Africa"

ROYAL INSTITUTION (at 21 Albemarle Street, London, W 1), at 5 15 p.m.—Sir George Dyson "The Origin and Development of Early Musical Forms", (2) "Purcell and Couperin"

ROYAL STATISTICAL SOCIETY (at the Royal Society of Arts, John Adam Street, Adelphi, London, W C 2), at 5 15 p.m.—Mr H. Leak and Mr A. Maizels "The Structure of British Industry"

INSTITUTE OF CIVIL ENGINEERS (at Great George Street, Westminster, London, S W 1), at 5 30 p.m.—Dr H. Chatley "Dredging Machinery"

INSTITUTE OF ELECTRICAL ENGINEERS (RADIO SECTION) (at Savoy Place, Victoria Embankment, London, W C 2), at 5 30 p.m.—Discussion on "Aspects of Post-War Valve Standardization" (to be opened by Mr A. H. Cooper)

Wednesday, February 21

BRITISH SOCIETY OF ANIMAL PRODUCTION (at the London School of Hygiene and Tropical Medicine, Keppel Street, Gower Street, London, W C 1), at 10 30 a.m.—Discussion on "Meat" At 11 15 a.m.—Major W. H. Warman and Mr R. W. Pomeroy "Supplies" at 2 p.m.—Dr E. H. Callow "Food Value, Quality and Grading of Meat with special reference to Beef" at 3 15 p.m.—Mr T. Shaw "Marketing and Distribution"

ROYAL SOCIETY OF MEDICINE (at 1 Wimpole Street, London, W 1), at 2 p.m.—Discussion on "The Veterinary and Medical Control of the Milk Supply" (to be opened by Mr H. T. Matthews (Veterinary), Dr W. A. Lethem (Medical) and Mr Clyde Higgs (Agricultural))

BRITISH SOCIETY FOR INTERNATIONAL BIBLIOGRAPHY (at the Institution of Electrical Engineers, Savoy Place, Victoria Embankment, London, W C 2), at 2 30 p.m.—Mr E. M. Bennett "The Classification of Inventions disclosed in United Kingdom Patents Specifications", Mr H. Rottenburg "Towards a Revision of the Engineering Section of the Universal Decimal Classification"

Thursday, February 22

LINNEAN SOCIETY OF LONDON (joint meeting with the ZOOLOGICAL SOCIETY OF LONDON) (at Burlington House, Piccadilly, London, W 1), at 2 30 p.m.—"The Land's End and Beyond" (a colour-film with commentary by Mr John Chear), Mr Paul de Laszlo "Colour Photography as applied to Biology", "Ethiopia" (a colour-film with commentary by Mr H. G. Hope Gill)

ROYAL INSTITUTION (at 21 Albemarle Street, London, W 1), at 5 15 p.m.—Prof James Gray, F.R.S. "Locomotor Mechanisms in Vertebrate Animals", (4) "Nervous Control of Movement"

Friday, February 23

INSTITUTE OF FUEL (joint meeting with the NATIONAL SMOKE ABATEMENT SOCIETY) (at the Institution of Electrical Engineers, Savoy Place, Victoria Embankment, London, W C 2), at 10 a.m.—Conference on "Post-War Smoke Abatement" Dr G. M. B. Dobson, F.R.S. "A Statement of the Problem", Major S. F. Markham, M.P. "The Effects on Civilisation of Atmospheric Pollution", Mr A. Blackie "Domestic Smoke", Mr M. G. Bennett "Railway Smoke"

ROYAL SOCIETY OF MEDICINE (at 1 Wimpole Street, London, W 1), at 4 30 p.m.—Prof Robert Debré (Professor of Pediatrics in Paris) "Conditions of Children in France under the Occupation"

PHYSICAL SOCIETY (in the Lecture Theatre of the Science Museum, Exhibition Road, South Kensington, London, S W 7), at 5 p.m.—Mr F. W. Cuckow "The Electron Microscope and its Applications"

ROYAL INSTITUTION (at 21 Albemarle Street, London, W 1), at 5 p.m.—Prof Benjamin Farrington "The Character of Early Greek Science"

Saturday, February 24

ASSOCIATION FOR SCIENTIFIC PHOTOGRAPHY (at Caxton Hall, Westminster, London, S W 1), at 2 30 p.m.—Mr D. R. Barber and Mr E. H. Amstein "Factors Influencing the Choice of Photographic Materials for Use in Quantitative Spectrography"

INSTRUCTION OF MECHANICAL ENGINEERS (GRADUATES' SECTION) (at Storey's Gate, St. James's Park, London, S W 1), at 3 30 p.m.—Mr N. Haulon "The Problems involved in the Establishment of Large Works in a Country District"

APPOINTMENTS VACANT

APPLICATIONS are invited for the following appointments on or before the dates mentioned

ASSISTANT MUNICIPAL ENGINEER by the Accra Town Council, Ghana Coast—The Ministry of Labour and National Service, Appointments Department, Central (T and S) Register, Room 5/17, Sardina Street, Kingsway, London, W C 2 (quoting Reference No. E 1174 A) (February 22)

ASSISTANT ELECTRICAL ENGINEER for Colliery Power-House Overseas (India)—The Ministry of Labour and National Service, Appointments Department, Central (T and S) Register, Room 5/17, Sardina Street, Kingsway, London, W C 2 (quoting Reference No. D 1023 XA) (February 22)

TEACHER (resident, certificated, graduate or non-graduate) GENERAL SCIENCE (preferably including AGRICULTURAL SCIENCE) the Junior Technical School in Agriculture, Pibwriwvd—The Director of Education, County Education Offices, County Hall, The Castle, Carmarthen (February 24)

CHEMIST (Metallurgist) for large engineering factory on North-East Coast—The Ministry of Labour and National Service, Appointments Department, Central (T and S) Register, Room 5/17, Sardina Street, Kingsway, London, W C 2 (quoting Reference No. F 3385 A) (February 24)

HEAD OF THE ELECTRICAL ENGINEERING DEPARTMENT—The Principal, Mining and Technical College, Church Street, Barnsley (February 24)

SENIOR and highly qualified MECHANICAL ENGINEER with specialized up-to-date knowledge of the Design and Operation of Large Steam Turbines and/or Boilers for highly efficient steam cycles—The Ministry of Labour and National Service, Appointments Department, Central (T and S) Register, Room 5/17, Sardina Street, Kingsway, London, W C 2 (quoting Reference No. C 2467 XA) (February 26)

MECHANICAL ENGINEER (resident) to supervise the installation of Boiler, Turbine and other Plant in a 100,000 kW Station now under construction (Reference No. C 2468 XA), and several ASSISTANT MECHANICAL ENGINEERS and ASSISTANT ELECTRICAL ENGINEERS with experience in the Design, Specification and Construction of Power Station Plant (Reference No. C 2469 XA)—The Ministry of Labour and National Service, Appointments Department, Central (T and S) Register, Room 5/17, Sardina Street, Kingsway, London, W C 2 (quoting the appropriate Reference No.) (February 27)

CIVIL ENGINEERS (4) for the duties of ASSISTANT DIVISIONAL ENGINEER in the Irrigation Department of the Sudan Government—The Ministry of Labour and National Service, Appointments Department, Central (T and S) Register, Room 5/17, Sardina Street, Kingsway, London, W C 2 (quoting Reference No. E 1378 A) (February 27)

TEACHER OF MECHANICAL ENGINEERING SUBJECTS, and a TEACHER OF ELECTRICAL ENGINEERING SUBJECTS—The Principal, South Technical College, Beaconsfield, Southall, Middx (February 28)

CHEMISTS in the Directorate of Food Inspection in India—The Ministry of Labour and National Service, Appointments Department, Central (T and S) Register, Room 5/17, Sardina Street, Kingsway, London, W C 2 (quoting Reference No. F 3592 A) (March 1)

CHIEF SUPERINTENDENT in a Government establishment concerned with the development of Army Radar—The Ministry of Labour and National Service, Appointments Department, Central (T and S) Register, Room 5/17, Sardina Street, Kingsway, London, W C 2 (quoting Reference No. D 1082 A) (March 3)

ENGINEER to take charge of all ENGINEERING and ASSOCIATE SERVICES in large old-established Works in North Midlands area—The Ministry of Labour and National Service, Appointments Department, Central (T and S) Register, Room 5/17, Sardina Street, Kingsway, London, W C 2 (quoting Reference No. C 2453 XA) (March 6)

LECTURER IN ELECTRICAL ENGINEERING, to teach Day and Evening Students for London External B.Sc. (Eng.) and for Ordinary and Higher National Certificates in Electrical Engineering in the Norwich City College and Art School—The Director of Education, City Hall, Norwich (March 9)

ENGINEER for position of Personal Assistant to the Chief Engineer of a large iron and steelworks combine in the North of England—The Ministry of Labour and National Service, Appointments Department, Central (T and S) Register, Room 5/17, Sardina Street, Kingsway, London, W C 2 (quoting Reference No. C 2452 XA) (March 12)

RESEARCH ENGINEER immediately to organize and control Laboratory and Experimental Department of progressive manufacturing Company situated in N.W. London area—The Ministry of Labour and National Service, Appointments Department, Central (T and S) Register, Room 5/17, Sardina Street, Kingsway, London, W C 2 (quoting Reference No. C 2462 XA) (March 12)

PRINCIPAL OF THE SOUTH-EASTERN AGRICULTURAL COLLEGE, Weybridge—The Clerk to the Governors, 11 Bank Street, Ashford, Kent (March 19)

LABORATORY ASSISTANT IN THE DEPARTMENT OF BOTANY—The Secretary, Bedford College for Women, Regent's Park, London, N.W. 1

LECTURER (full-time) IN ELECTRICAL ENGINEERING—The Principal, Technical College, Brunswick Road, Gloucester

CROP RESEARCHER at Sub-stations in Shropshire and Northumbria—The Secretary, National Institute of Agricultural Botany, Huntingdon Road, Cambridge

NATURE

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SELECTION FOR HIGHER APPOINTMENTS

THE importance of efficient management has been much discussed during the past few months, a recent reference being the address by Mr. W. C. Devereux, of High Duty Alloys, Ltd., at the British Association conference on "The Place of Science in Industry" (see *Nature*, January 29, p. 96). The report of the Higher Appointments Committee set up by the Minister of Labour and National Service in July 1943 was therefore awaited with unusual interest*. The Committee, of which Lord Hankey was chairman, was appointed to consider and report upon the arrangements which should be made to facilitate the employment after the end of hostilities of men and women qualified to undertake responsible work in the professions or elsewhere, with particular reference to (a) the organization, premises and staff of the Appointments Department of the Ministry of Labour and National Service, and (b) the arrangements which should be made for co-operation between the Appointments Department and other organizations and institutions and universities, in Great Britain and abroad. It is thus of fundamental importance with respect to the re-allocation of employment involved in demobilization, though it was not one of the functions of the Committee to consider the quantitative aspects or trends of employment that is one of the functions of the Interdepartmental Standing Committee on Education and Training, appointed at the same time as the Higher Appointments Committee, and with the same chairman and secretariat, primarily to consider and report on employment prospects in the various professions and callings. Despite this limitation, the present report is an important contribution to the discussion of a subject which was freely ventilated in the papers contributed recently by Sir Ernest Simon, Dr C P Snow and Sir Lawrence Bragg in a recent number of the *Political Quarterly* dealing with the future of the universities, and the report is as emphatic as those papers that attention to this quantitative aspect is a primary condition for the efficient functioning of any appointments department.

The Appointments Department of the Ministry of Labour and National Service was itself an outcome of experience with the Central Register, and the report includes a review of the work of the Department and of the Central Register, supplementing the review which appeared three years ago in the sixteenth report of the Select Committee on National Expenditure for the 1941-42 Session (see *Nature*, 150, 733, 1942). Before proceeding to this review, the present report emphasizes the general approach of the Committee to the problem, which is essentially that of making sure, in the interests of the country as a whole, that full and proper use is made in the future of its greatest single asset, the trained ability and intelligence of its men and women. The wisdom of that approach was emphatically supported

* Higher Appointments Report of the Committee appointed by the Minister of Labour and National Service in July 1943 (Cmd 6576) Pp. 62 (London H M Stationery Office, 1945) 1s net

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at the British Association Conference on "The Place of Science in Industry" referred to above, which, while providing evidence that Great Britain has at its disposal resources of ability and intelligence second to none, showed that in certain fields those resources are quantitatively far short of what is required.

The Committee concludes first that the effort or enterprise of private organizations with their sectional, geographical and often financial limitations cannot provide all the machinery direct provision by the State is indispensable. Accordingly, the Committee's recommendations provide in some detail for the organization of a national agency for higher appointments. While most of the recommendations relate to this question, the Committee does not consider that the mere provision of an employment agency, however efficient, will by itself be enough. It regards the placing work of the Appointments Department as the focal point of a service for providing men and women and their employers with the best available information, advice and help. The Appointments Department must in fact carry out its task with the widest conception of the public service that can thereby be rendered, or it will not function at all.

With this conception of the practical task, the Committee stipulates three conditions of success. First, the organization must be such as to encourage all men and women within the field to use it. Secondly, it must have the skill and knowledge necessary to assess the ability, actual or potential, of the men and women with whom it deals, and to know the kind of job to which each is most suited, as well as the best advice to give where the choice of a career or training for a career is involved. Thirdly, it must command the confidence of employers, so that they will not only use it to the full and thus provide it with the maximum opportunity for finding jobs, but also be prepared to take an interest in it and help it in its work.

To achieve these aims, the organization must be planned on the right lines and then staffed with the right officers and, like Dr C. P. Snow and also the earlier memorandum on graduate employment issued by the National Union of Students, the report stresses that in a human problem such as this the indispensable foundation of success is the appointment of the right men and women to tackle it. In the main, the report is concerned with the re-settlement period of four or five years after the War, and does not deal in detail with the ultimate shape of the Appointments Department. The Committee stresses, however, in regard to this question of staffing, that a very substantial proportion of the staff of the Department must, at the outset and throughout the re-settlement period, be drawn from outside the permanent Civil Service. There will be a unique opportunity at that time to obtain the services of men and women with suitable qualifications and experience who are leaving war service, either in Government departments or in the Fighting Services. While those permanent officials of the Ministry who are particularly well qualified for such work should be allotted to the Appointments Department so far as possible,

there can be little doubt that among the remaining officials of the Department recruited from outside the permanent Civil Service will be found a number worthy and willing to continue as permanent officers.

Reviewing next the present organization, the report points out that early in the War it became clear that the Central Register is divided sharply into two categories. The demand for those in the first, comprising engineers, scientific workers, etc., was much greater than the supply, while for those in the second, comprising persons with administrative, executive and business qualifications, the exact reverse obtained, and with the supply of such persons increasing with the reduction or closing down of industrial and commercial undertakings, the Central Register proved an unsatisfactory instrument for dealing with persons in this category. The Appointments Register under the new Appointments Department, which began to operate in March 1942, was created to meet this difficulty. The Supplementary Register was abolished, and new decentralized arrangements made for dealing with this second category. The Appointments Branch has thirty-one offices throughout Great Britain and deals not only with all persons other than engineers, scientific workers, and the like who possess higher qualifications, but also with those who fall below the standard required for enrolment on the Central (Technical and Scientific) Register.

The work done by the Appointments Department for private employers has steadily increased, and the Department is already seeking to provide the kind of service which it will have to give on a larger scale after the War. While the work of the Appointments Department has been decentralized, that of the Central (Technical and Scientific) Register, meeting a national rather than a local need, remains centralized. Technical officers were appointed in September 1940 to the five technical sections of the Register, and there are six advisory committees serving architecture and public utilities, chemistry, civil engineering, electrical engineering, mechanical engineering and scientific research.

Pointing out that the area covered by each employment exchange is far too small for dealing with higher appointments, in which both applicants and vacancies require far more individual attention, the Committee proposes that the appointment offices should form part of the regional organization of the Ministry of Labour, with the exception of the London Appointments Office, which should continue as part of the headquarters of the Ministry. The line of demarcation between appointment offices and employment exchanges should remain just above the level of foreman and clerk. Demarcation by grade and by the level of remuneration are rejected, as is the drawing of a special line of demarcation for each profession or section of industry or commerce. Demarcation by remuneration, for example, would be liable to exclude beginners in many professions and thus deprive the Appointments Department of one of its most important functions.

The number of appointment offices should be as

small as possible, so as to secure a large area and greater prospects of filling vacancies from those on its own register, and to facilitate the employment of more specialized and expert staff. Not more than fifteen offices are recommended, to be situated in London, Southampton, Bristol, Cambridge, Birmingham, Nottingham, Leeds, Manchester, Liverpool, Newcastle-on-Tyne, Edinburgh, Glasgow and Cardiff, with local representatives of the Department in perhaps sixty or more other centres. The areas of these offices should be settled solely with reference to the requirements of the work.

Arrangements for pooling applicants between appointment offices are necessary, and the present system of circulating particulars of vacancies should continue, while particulars of any vacancy for which it appears unlikely that an appointments office can submit really suitable candidates should immediately be circulated to the other offices. Particulars of vacancies of the highest type should be sent to the London Appointments Office, which should be responsible for filling them. Arrangements are recommended for handling centrally vacancies which are likely to be filled by engineers with full professional qualifications and applicants who are likely to be acceptable for such vacancies. Vacancies for scientific workers of any type for which the market is essentially a national market, for example, physicists and biologists, should be dealt with centrally, and where an occupation is handled wholly or partly at the centre, officers possessing high academic and professional qualifications should be employed upon the work. Moreover, since those who possess high professional qualifications are not always employed in a professional capacity, to avoid any undue separation between the work of the Appointments Department in respect of such occupations and its general work, the Committee recommends that the branch dealing with occupations wholly or partly centralized should form part of the London Appointments Office.

An admirable survey of the work of the appointments office and of the advisory service provides ample evidence of the valuable contribution which such an office and service, properly staffed and run, might make to the effective use of scientific and technical man-power. The Appointments Department, for example, should be well placed to make available to the public information about trends of employment and particulars regarding the various occupations which are rarely available to the university appointments boards, and its advice upon the choice of a career should be based upon the guidance of the Interdepartmental Standing Committee on Further Education and Training. Another suggestion in the report in the same field is the issue of road-sheets dealing with the employment situation.

One of the most important sections of the report is that which deals with public relations and co-operation with other organizations. Leaving on one side the detailed recommendations for bringing the services offered by the Appointments Department to the notice of the general public and in particular to

the members of the Forces, the scientific worker will be especially concerned with the measures proposed for interesting professional, commercial and industrial organizations in the area of each appointments office. This is of special importance not merely because many centres are without an appointments office, but also because it is not intended that the new organization should have a monopoly in the work of filling higher appointments. It is intended rather to design an organization which will be used purely on its merits, and accordingly its relation to the existing appointments bureaux of such professional bodies as the Royal Institute of Chemistry and the British Association of Chemists, or the Professional Engineers' Appointments Bureau, which the Institutions of Mechanical, Electrical and Civil Engineers are proposing to establish to assist the re-settlement of engineers after the war, in co-operation with the Ministry of Labour, may be of vital importance.

The recommendations of the report in this connexion are straightforward. First, every appointments office should have a development section devoted to this work, and while local advisory committees are not suggested, it should be a primary duty of the officer in charge of each appointments office to take all appropriate steps to secure the friendly interest of all persons and organizations in the area covered by the office whose co-operation will conduce to success, and to establish relations with knowledgeable persons, including officials of professional institutions, with the view of their giving advice on subjects on which they are experts and expert assistance in exceptional cases, such as interviewing an applicant whose case presents special problems. On the other hand, in view of the experience of the advisory committee of the Department during the War, the Committee recommends that there should be national standing advisory committees representative of the principal professions and occupations, meetings of which can be called when advice or assistance is desired by the headquarters of the Appointments Department. While the Committee holds that the Appointments Department must be responsible for submitting to the employer the best possible list of candidates for any vacancy, subject to this paramount principle, it wishes to see co-operation with other employment agencies, such as the university appointments boards and professional institutions which operate in this field, developed to the highest degree.

Special consideration is given in the report to the university appointments boards, and the Committee considers that the registration of graduates with the appointments offices as well as with the university appointments boards would both assist employers to make full use of men and women with university training and also widen the opportunities for employment of graduates. Concrete suggestions as to the form which such co-operation might take are included in the report, and their adoption might go far to meet some of the criticism of university appointments boards to be found in the National Union of Students' report "Graduate Employment",

as well as in "Redbrick University" and in Dr Snow's recent article in the *Political Quarterly*. It will be noted that in fact the report provides for two of the three practical steps emphasized as necessary by Dr. Snow—a standing Government committee to report at least once each year on trends in employment of graduates; and that the Appointments Department of the Ministry of Labour should act in close touch with this standing committee and have as its essential task the diffusion of information to undergraduates.

There can be little doubt that a Government department would be much better equipped to discharge such responsibilities as those which the National Union of Students suggests should be entrusted to the university appointments boards. Furthermore, the observations on the staffing of the appointments offices have a close bearing on the staffing of university appointments boards, and if the latter are, as Dr. Snow suggests as the third step, strengthened in the large universities on the Cambridge scale and developed on tutorial lines in the smaller universities, their effectiveness cannot fail to be increased by contact and co-operation with a Government Appointments Department staffed as advocated in this report.

There is a further point with regard to co-operation with the professional institutions which are active in this field. Some of them have old-established and efficient appointments bureaux and may tend to look askance at a new Government agency, at least until it has gained their confidence by good work. The report, which establishes beyond question the need for a national organization, should equally dispose of any fears as to competition and rivalry. What is required is in fact complete and friendly co-operation—a co-ordinated effort to ensure the best possible use of the specialized knowledge and ability which constitute one of the most precious assets of Great Britain. It may well be that one consequence will be some diminution, if not elimination, of overlapping activities in this field on the part of rival professional organizations. The engineers are clearly moving in this direction. Even more fundamentally, it is a reminder that the functions and duties of professional associations change, and that, as Prof H. Laski has pointed out, in a new age of full employment, their protective and defensive functions may have less meaning and importance, while other duties increasingly invite their zeal and service.

UNIVERSITY GRANTS IN GREAT BRITAIN

SIR JOHN ANDERSON'S statement in the House of Commons on the Treasury grants to be made available to the universities and university colleges of Great Britain during the next few years must have come as a great relief to those who are responsible for the finances of these institutions, for the recurrent grant for general university purposes is to be nearly doubled by an addition of £2,000,000 in each of the

next two years, and there is to be a further grant of £1,000,000 for developments in the medical schools arising out of the recommendations of the Inter-Departmental Committee's report, and £500,000 for grants to the teaching hospitals on the recommendation of the same committee. The grants for future years will be reviewed at the end of the two year period. For capital expenditure, a token sum of £250,000 is to be made available to the University Grants Committee for distribution during the coming year. A sum of £5,900,000 in all will thus be included in the 1945 estimates as a grant in aid of the universities, colleges, medical schools, and teaching hospitals of Great Britain.

The Chancellor's statement is noteworthy not only because of the generous allocation of funds which it discloses, but also because of the evidence it affords of the receptiveness shown by him to the advice tendered by the representatives of the universities and university colleges, and by the University Grants Committee, which is charged with the duty of administering the grant.

The approximate doubling of the grant for general university purposes will, however, provide little more than is required for the long overdue increase in the salary scales of members of university staffs. An increased income of not less than £1,500,000 per annum is needed immediately to adjust these salaries to a level comparable with that prevailing in other professions which are recruited from students of similar training and standard of attainment. It is greatly to be hoped that the lead now given by the Government will be generously followed by local authorities, so that provision will be forthcoming to make university education available to the greatly increased numbers of students who will soon be seeking it. This will require an increase in the existing staffing of departments and a larger provision for maintenance charges of all kinds.

Sir John Anderson stated that in view of the restrictions on building which are likely to operate during the years immediately following the War, it seems unlikely that the universities will have opportunities for any considerable capital expenditure during the next year or two, but he added that if the grant of £250,000 for capital expenditure should prove insufficient, the possibility of its being increased within the financial year would not be ruled out. Capital expenditure is needed not only for the erection of new buildings but also, and more immediately, for the purchase of sites on which the new buildings can be erected. In many universities and colleges the need of funds for the acquiring of land, now available as a matter of pressing urgency if the opportunity of expansion on to convenient sites is not to be permanently lost. It thus seems probable that the University Grants Committee will receive requests from the universities, during the present year, for a greater total sum than that provisionally allocated by the Chancellor to capital expenditure in 1945. It is obvious, for example, that £250,000 would not go very far towards providing the additional sites now urgently needed by the many colleges and institutions of the University of London alone.

Universities are rightly zealous in safeguarding their autonomy, and satisfaction will no doubt, be derived from the fact that, in announcing the special grants for medical schools, the Chancellor did not threaten the imposition of financial sanctions, as did the Minister of Health in a reply he made in the House of Commons a few weeks ago. On that occasion, in a written reply relating to the report of the Inter-Departmental Committee on Medical Schools, Mr Willink indicated that the Government's acceptance of the principle of increased grants for medical education and research was dependent on a revision of the medical curriculum being carried out at an early date. Such a decision by the Government, taken without prior consultation with the university authorities, however well-founded it might be, would be a grave departure from established procedure and a menace to the academic freedom of the universities.

SCIENCE AND SALVAGE

Science and Salvage

From the German "Verwertung des Wertlosen" Editor, Claus Ungewitter. Translated by L. A. Tierney and G. Ham. Pp 183 (London Crosby Blackwood and Son, Ltd, 1944) 12s 6d

WASTE, begotten of ignorance out of laziness, is no new phenomenon; it is probably coeval with man, if not with his progenitors. But primitive man had neither the knowledge and incentive nor the use of machines to convert his scrap into utilizable material, modern man has all these, but in general fails to apply them on any considerable scale, unless he is compelled thereto by war or by the expectation of profit. Modern industries based upon science have, however, not only realized the need of recovering materials hitherto wasted, but also they themselves have created new wastes to be recovered, such as chemical by-products and metallurgical scrap.

The words 'waste' and 'salvage' are sometimes used loosely. Strictly speaking, a waste material is one which might be recovered and re-used, with or without pre-treatment, but many, including the author(s) of the book under review, use them in connexion with low-grade minerals, with certain constituents of sea water, and even with certain atmospheric gases. Such raw materials, of actual or potential use, can scarcely be called 'waste', and the term should be restricted to substances and articles that have already been manipulated by man, either directly or by means of machines.

The German original of this book, entitled "Verwertung des Wertlosen" (utilization of the worthless), comprises a series of articles that appeared in *Die chemische Industrie* shortly before the outbreak of the present War, they were published in book-form in 1938, with an introduction by Field Marshal Göring, and may therefore be taken as authoritative and up to date in regard to pre-war German practice, or most of the processes mentioned—few are described in detail—have either originated or been developed in Germany. The amount of work done here in this connexion can only be described as amazing, but, unfortunately, one cannot repress the thought that most of it was undertaken to render Germany as self-sufficient as possible and to build

up the *Wehrmacht* with the ultimate object of attaining world domination. In 1939, Germany produced about 80 per cent of her food requirements and almost two-thirds of her industrial raw materials. If, in the future, she were cut off economically from the outside world, and were left with her present territory, it is quite possible that she might live on her own resources. Although starch-bearing tropical crops like rice and cassava could easily be dispensed with, luscious tropical and sub-tropical fruits, tea and coffee would have to go by the board, fats, oil, rubber and fibres could be made artificially, and cellulose in its various forms could be readily produced at home. Further, if metallurgical science continues to advance at its present rate, substitutes for some of the commoner metals and more particularly for certain rarer metals, like tungsten and molybdenum, would be forthcoming. Coal ash, as the authors point out, could supply appreciable quantities of zinc, arsenic, cobalt, nickel, molybdenum, chromium, vanadium, silver, gold, platinum and beryllium. National self-sufficiency in Germany and in many other countries is distinctly possible, but, as many will think, very undesirable in a peace-loving progressive world.

The wide range of subjects discussed in the book may be gleaned from the following abbreviated chapter headings: atmospheric gases, the sea, low-grade mineral resources, peat, forestal products, agricultural wastes, scrap and worn materials, municipal refuse, sewage, chemical by-products and coal ash. Few, if any, of the processes outlined will be unfamiliar to specialists, but even they will be interested in the efforts made in fields other than their own. It is to directors of large laboratories and research institutions, and not least to economists and 'business executives', that the book will make a special appeal. During the War of 1914–18, many patents for the recovery of waste were taken out, and but very few survived the ordeals of peace, the chief reason being that they did not 'pay'. Hence the future of scientific salvage will depend as much upon economic and political conditions as upon advances in science and technology. In certain cases it may well be advisable for Government or local authorities to assist in the initiation, development, and perhaps the operation of processes that may be deemed of primary importance, for it can scarcely be expected that public companies should risk their shareholders' money in such enterprises. Processes essential to public health and the national economy, like the treatment of sewage and of household refuse, would here come into the picture, and generally it may be postulated that public money should be used only for the provision of materials, etc., to meet basic needs, such as those used for food, power, clothing, shelter and communications. Apart from these, it may well be found that many of the ingenious processes evolved are inadvisable and redundant, for example, the recovery of materials that are renewed annually or at slightly longer periods by solar radiation.

Cupidity, ultra-nationalism and bad economics have in the past prevented many of the gifts bestowed by a bounteous Nature from becoming available to the people who need them. If nations could be made to realize, however slowly, by enlightened education that they are all members one of another, and if the fourth term of the Atlantic Charter, that all nations have free access, on equal terms, to the trade and to the raw materials of the world, could be implemented, much of the human effort that may be devoted to

the recovery of waste products could be saved, leaving more time and energy for devotion to constructive and creative work in science, art and letters

A word of praise is due to the translators for having produced a good, readable version of the original which, if it conforms to type, bears the imprint of what Schopenhauer called the essentially German characteristic—ponderosity. E. H. TRIPP.

A PACIFIC SEAWEED FLORA

Marine Algæ of the Monterey Peninsula, California
By Prof Gilbert M Smith Pp ix+622 (98 plates)
(Stanford University, Calif Stanford University Press, London Oxford University Press, 1944) 36s net.

IN most maritime countries there are certain stretches of the coast-line that offer peculiarly favourable conditions for the study of marine life. Such a one is the Monterey Peninsula in California, which is noted not only for the wealth and diversity of its seaweeds, but as the domicile of the Hopkins Marine Station from which, since its establishment in 1892, many important contributions to our knowledge of the marine life of the Pacific have issued. Among these must be ranked the work which forms the subject of the present review. All botanists who have had or may have the good fortune to visit this privileged region will owe a debt of gratitude to the author for giving them the benefit of his prolonged experience of its seaweed population. Smith's valuable book, which deals with the green, brown and red Algæ of the Monterey Peninsula, is, however, far more than a local flora, since approximately three-quarters of the seaweeds recorded from the Pacific coast of North America occur on the shores of the Peninsula. Moreover, it constitutes the first recent taxonomic account of the American Pacific Rhodophyceæ, since the section dealing with this class in Setchell and Gardner's "Marine Algæ of the Pacific" was never published.

The brief introduction contains a useful section on the distribution of the seaweeds on the shores of the Peninsula, which might with advantage have been fuller. The numerous keys for the determination of families, genera and species are supplemented at the end of the book by comprehensive keys based almost entirely on external form and vegetative structure and designed to facilitate the ready recognition of the genera. The classification follows familiar lines, the Chlorophyceæ are grouped according to the scheme adopted by the author in his other books, while the Phæophyceæ and Rhodophyceæ are arranged on the general lines proposed by Kilm. As I have pointed out elsewhere, I am doubtful as to the value of the grouping of Phæophyceæ under Isogeneratæ and Heterogeneratæ, since in my opinion it obscures relationships. Smith is logical in including among the Ectocarpales (*sens limit*), in the Isogeneratæ, the genus *Heterochordaria*, which probably has an isomorphic life-cycle, but its inclusion here removes it from similarly organized forms comprised in the Chordariales, with which it is justifiable to assume some degree of relationship. The author also adopts a new basis of delimitation between the genera *Acrochaetium* and *Rhodochorton*, referring to the latter all those species of *Acrochaetium* in which tetrasporangia are known to occur. This will scarcely find favour with most algal workers, it might be more

appropriate to adopt Drew's suggestion of grouping all the species in one single genus *Rhodochorton*.

The designations macrospores and microspores applied to the eggs and sperms of Fucales, rest on a speculative basis that they appear out of place in a work of this kind. In general, however, the diagnoses, incorporating a considerable number of new observations of the author's, are distinguished by their clarity and their ample character. This feature combined with the copious and excellent illustrations (many of them the work of Mrs C F Janisch) and the general finish of the book, contribute to make this one of the most noteworthy taxonomic works on Algæ published during the present century.

F E FRITSCH

FUNDAMENTALS OF RADIO PHYSICS

Physics and Radio

By M Nelkon Pp viii+388 (London Edward Arnold and Co., 1944) 8s 6d net

THE extensive application of radio technique during the past few years has given rise to a need for books on the general basic principles of radio physics. The book under notice goes part way to fulfil this need, and as the author states in the preface, the book should be useful to radio mechanics, wireless operators and students of School Certificate standard requiring a knowledge of the elements of radio.

The first fifteen chapters deal with the fundamental physical principles of electricity and magnetism. Six chapters are then devoted to considerations of the basic properties of valves and their use in various circuits for rectification, amplification and oscillation, these various functions should readily be understood in principle from the treatment given. In a chapter devoted to aërials, the subject is made clearer by several useful analogies with acoustical phenomena. Next follows an account of the fundamental ideas underlying the superposition of intelligence on the carrier wave at the transmitter and its subsequent separation from the carrier at the receiver. Chapter 24 gives first an outline of several phenomena observed in the study of light including reflexion and refraction from the point of view of wave theory, polarization and the differences between longitudinal and transverse waves are also discussed. This outline is intended to serve as an introduction to the behaviour of radio waves in the ionosphere, and suffers somewhat from its brevity, but the treatment given serves to explain skip distance and fading effects. The last of the twenty-five chapters describes a commercial cathode ray oscillograph, and the development of time bases for use therewith. Each chapter ends with a concise summary of the salient points and with a good selection of exercises to be worked out by the reader.

The book is very well written, is liberally illustrated and is eminently suited to the class of reader for which the author intended it. It may even have a wider appeal, for it involves only the most rudimentary knowledge of mathematics, and the calculus is avoided entirely. A very good feature is the inclusion of numerous practical examples which are worked out in the text, so that the student may realize the numerical significance of the various formulæ and properties of circuits.

SCIENCE IN SOCIAL AND INTERNATIONAL PLANNING, WITH SPECIAL REFERENCE TO INDIA*

By PROF MEGHNAD SAHA, F.R.S.

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THE League of Nations was formed after the War of 1914-18 to promote goodwill and peace among nations, and it is one of the greatest calamities of history that it could not achieve its objective, but it undertook many important surveys on international affairs, knowledge of which is useful for coming to the heart of the international problem. One is the Year-Book, published by the Labour Organisation of the League, which shows in tabulated form the production of commodities in the different political units of the world. This is indispensable for arriving at a proper estimate of the comparative economic condition of different units. The other was the report of the committee for framing an international calendar for the whole world, which, if it could have been adopted, would have gone a great way to promote goodwill and understanding among the principal nations of the world.

The Year-Book must have been very largely used by economists. I myself, while a member of the National Planning Committee of the Indian National Congress†, tried to form, from the contents of the Year-Book, some idea of the average *per capita* income of the different countries of the world. This proved to be an almost hopeless task, but it was thought that an estimate of the same quantity might be obtained from an entirely different angle, namely, the total energy-production in a country, for we can take wealth to be directly proportional to the output of energy. This is a comparatively easier task, for the energy output is mainly due to the following agencies: (1) Work done by man and domesticated animals. (2) Work done by inanimate agencies mainly engines using coal, petrol, and other kinds of fuel (bagasse or wood). (3) Work done by electricity derived either from thermal (coal or petrol), or from hydro-electric, sources. Other sources of energy output are negligible at the present time.

Suppose we can estimate the energy output under the three headings accurately, add them up, and divide the whole by the total population of the country. We get a figure which shows the average *per capita* energy output for a country. For the sake of brevity, we shall denote this figure by the term *energy-index*. Let us now see how to calculate the energy-index for a few representative countries of the world just before the outbreak of the present War.

The League of Nations Year-Book gave total production of electrical energy from thermal and hydro-electric sources against every country, so that it is a perfectly simple matter to calculate the contribution to energy-index from electricity for every country. It was 650 for the United Kingdom, 1,700 for Canada, 1,300 for Sweden, and about 1,500 for the United States. These are the most advanced countries of the

world, but we may also take some others, the figure was 180 for Mexico, and for progressive countries like the U.S.S.R., it was rapidly increasing from very small figures to those attained by the advanced countries. In countries like Poland, the figure was stationary. For India and China, no figures were available, but according to a Government of India estimate, the total production of electrical energy in India in 1942 was 3,500 million units, so that it comes to only 9 units a head for India. China was rather worse.

It is more difficult to calculate the energy-production from coal or other fuel, for coal mined or imported into a country has many other uses besides energy production, and the efficiency of energy production varies widely. It is not worth while to give all the technical details, but it was concluded that the contribution to the energy-index from coal and other fuel in the United Kingdom amounted to nearly 1,300, and somewhat more in the United States. In India, it could not have been more than 20, for India produces only 26 million tons of coal against Britain's 200 millions, and the use of Indian coal is extremely wasteful.

We, therefore, find that, before the War, the energy-index in the year from inanimate sources amounted in Britain to about 2,000 and in the United States to about 2,500, in India it could not amount to more than 30, and even that is probably too liberal an estimate.

Where does the energy production by man and domesticated animals come in this picture? A man working eight hours a day for three hundred days in the year produces only 180 units, and assuming that one third of the population is engaged in productive work, which is not far from the truth, the average cannot be more than 60 units *per capita* a year. The energy production by animals, by wind and water-power in the Middle Ages would not exceed 20 units, so we are not far from the truth if we say that in the Middle Ages the energy-index in all countries amounted to about 80 units, with small variations from country to country. This is negligible compared with energy production in a modern country, by steam, electricity and petrol, and can be almost entirely left out. Man's function, in the present days of technocracy, is merely directive.

These arguments are simple enough, but we can draw from them some very important conclusions. It is obvious that in advanced countries of the world, man, by harnessing the forces of Nature, has increased the energy-index by twenty to thirty-five times within the last hundred years, and this has caused a profound revolution in society. Let us see what this revolution is.

Most old-fashioned history books tell us only of kings, emperors, nobility, and of the privileged few, and omit entirely the common man, and from their perusal we are apt to form sometimes a romantic, uncritical picture of ancient and medieval times. But critical historical research has shown that even two hundred years ago the standard of living for the ordinary person, and conditions of public health in every country, were appallingly low compared to modern standards. Only a few who possessed slaves could afford to have some 'comfort', but it was not much compared to the standards now enjoyed even by the ordinary citizen in an advanced country of the world. In the sixteenth century, there was terrible mortality among children, and even royal children used to suffer heavy mortality due to

* A lecture delivered before a joint meeting of the British Institute for International Affairs, and the British Association for the Advancement of Science, on November 10, 1944.

† The National Planning Committee was appointed by the president of the Indian National Congress in October 1938, with Pandit Jawahar Lal Nehru as chairman. It appointed twenty-nine sub-committees, held a number of discussions, and framed resolutions for the economic and social regeneration of India. Its activities were terminated in 1941 owing to the incarceration of the chairman.

diseases now found to be preventable, thanks to science.

The philosophy of kindness and service to our fellow-men was preached by all founders of great religions, and no doubt some great kings and ministers of religions in every country and at all ages tried to give effect to this (altruistic) philosophy. But the efforts were not successful, for the simple reason that the methods of production of commodities were too inefficient to yield *plenty for all*, which is an indispensable condition for practical altruism.

We can therefore hold that, *so far as individual life is concerned*, science has achieved the target aimed at by the great founders of religions in advanced countries of the world. The effects of maldistribution of wealth, due to historical causes, are being rapidly cured by the introduction of social laws.

The advanced States of Europe, and also the United States of America, began to move out of those dreadful medieval conditions during the seventies of the last century, when modern science began to develop and new methods of production were applied on a mass scale. As a result of a century of progress, individual conditions of living and public health have steadily improved in Britain and in many other countries of Europe and America. Probably the best index is afforded by the average life, which has increased from twenty-nine about a hundred and fifty years ago to fifty-eight in 1944 in the United Kingdom, and to sixty-three in the United States, according to reliable reports. Not satisfied with that, Britain is having a social insurance measure on the lines of the Beveridge Plan, which will take care of the man from the 'cradle to the grave'.

Indian Conditions

Let us now come to my own country—India. Figures have been given which show that the energy-index in India is not more than 100 units, or at best 120 units. It is twenty to thirty times smaller than in the advanced countries of the world. The National Planning Committee estimated the average income of the Indian in 1938 to be Rs. 65 or £5, which can be compared to the average income of the Britisher about the same time (nearly £120). This figure, when it was published, was challenged, but our method of approach—which is radically different—leads us to an identical conclusion*.

Recently the Royal Society sent a distinguished ambassador of science, Prof. A. V. Hill, to India, and he took pains, as no other man has previously done, to study first-hand the conditions of public health, and to some extent observe the general economic conditions in India. He has stated his findings publicly, and they are practically the same as mine. By whatever standards you measure, you find 90 per cent of India is still in the Middle Ages. The thin veneer of modernism which travellers find in the great cities of Bombay, Calcutta and Delhi must not lead you astray. Ninety per cent of India is still in the sixteenth century conditions of England. We have terrible child mortality, the conditions of public health are appalling, and 90 per cent of the people have to live in slums. They have scarcely any interest in life, and we are on the brink of disaster, as Prof. Hill has told the British public repeatedly.

* According to a P.E.P. report, the total income of Britain in 1944 was ten thousand million pounds, which makes the *per capita* income a little more than £200. This is due to war inflation, and is compensated by the cost of living. In India, the average income has risen during the War, but the cost of living has increased according to official estimates 2.6 times, and according to non-official estimate, nearly 3.5 times.

The National Planning Committee of the Indian National Congress had rightly concluded that India had been almost entirely untouched by modern scientific methods, and if she wanted to pass out of the present dreadful conditions, she must tackle seriously the great task of applying modern scientific and industrial methods for the development of her potential wealth, as has been done by the U.S.S.R. with signal success within the past twenty-five years.

Is there any indication that the problem is being properly understood by the central or provincial Government circles? The problem is so urgent that nobody can shut his eyes to it, and one would conclude so from the appointment of many post-war planning committees, but the pronouncements made by these committees from time to time only add to the general confusion. Some advocate road building without trying to find out who are the men who will use the roads, and for what purpose and by what conveyance, some advocate agriculture, others think there is an inherent antagonism between agriculture and industrialization, but the ordinary man only sees that the terms of superannuated officers are extended on higher salaries. The fact is that the planners lack *direction* from the centre.

It is obvious that the clearest way to define the objective would be to declare that India's *per capita* income should be progressively increased to modern figures compatible with her resources, and as a necessary first step, India's energy-index should be progressively increased to the figures attained in all modern countries. Let us put a definite target, say 100 units within the next ten years, and we shall also have to use this energy suitably. This is not a large figure, for even pre-war Mexico used to produce 180 units of energy per head, and we produce now only 9 units. Such a declaration, if it is forthcoming, would convince the people, as nothing else would do, of the Government's seriousness of purpose. The Government would have to set up proper machinery for producing electrical energy within the next ten years, and to find a use for the energy for the benefit of India's masses. Let us look at this figure from another angle. It is slightly larger than the pre-war production of electrical energy in the United Kingdom, and according to a P.E.P. report, nearly £600,000,000 was invested in the electrical industries in Britain. Probably a comparable amount will be needed in India, but if the undertakings are properly planned, many of the mistakes committed in the past can be avoided, and a smaller sum may be sufficient. It will also greatly promote trade relations between India and the United Kingdom, as in the case of the U.S.S.R., for India will have to depend for a long time yet to come on imported machinery for her development.

Industry vs Agriculture

If a policy of progressive electrification of India be agreed upon and undertaken, we shall have to spend most of the energy produced in industrialization. Many critics have seen in this policy a menace to agriculture and to the agricultural population, and have raised the cry of agriculture versus industry. But this is due to confusion of ideas, and a little thinking shows that there is really no conflict between industry and agriculture. As a matter of fact, the position of agriculture in India has been entirely misunderstood, and misinterpreted.

According to the census figure of 1931, which is the latest available to us, only 15 per cent of the popula-

tion of India is urban and 85 per cent is rural, of which nearly 70 per cent is directly dependent on agriculture. Anybody having the slightest knowledge of economics knows that this is a very unhealthy sign. Probably with the exception of China, no other country in the world has such a large percentage of her population on the land. In some parts of Bengal, the holding is two-thirds of an acre per head of the population. The remark of Julian Huxley, referring to the Tennessee Valley of twenty years ago, may be applied with far greater emphasis: "Primitive in their reproductive habits as in their farming methods, they multiply rapidly until they present a typical Malthusian population, pressing hard upon the land's capacity for subsistence."

How has this state of affairs been brought about? We have reasons for believing that before cheap factory goods began to pour into the markets of India, there was a far better balance between the people actually employed in agriculture, and the artisan classes. When industrial revolution started in England, the rural population of England was sucked into production centres, which rapidly grew into large cities, and the urban population grew rapidly. In India, the effect was in the reverse direction. When cheap factory-made goods began to pour into the markets of India, most of the artisan classes—weavers, spinners, blacksmiths, potters and metal workers—lost their jobs and became peasants. With the introduction of railways and steamships, people engaged in the transport trade lost their jobs and were thrown upon the land. The successive famine commissions have rightly diagnosed the excessive pressure on land to be one of the causes of malnutrition and recurrent famines, and recommended that the burden should be taken off the land by providing a large section of the population engaged in agriculture with industrial occupation. But the small amount of industrialization which had taken place in India is totally inadequate for taking the burden off the land.

But one must not forget that in spite of the disproportionately large number of men engaged in agriculture, there is not sufficient margin of safety as regards production of food for India's four hundred millions. The Bengal famine of 1943 appears to have focused the attention of the world on this point, and though this disaster was precipitated by a variety of causes, in which food shortage played a minor part, one must not forget that there is a chronic deficiency of food, both of vegetable and animal origin, and there is consequently permanent malnutrition. India is just on the verge of a crisis, as Prof. Hill has repeatedly stated, and any small cause may precipitate it. The fact is that, owing to over-population, which is itself a consequence of over-ruralization, man in India is making too much demand on the soil, which is not allowed to rest or recuperate. A survey of the productivity of the soil of India recently carried out by Dr. Burns, agricultural commissioner to the Government of India, shows that it produces on the average four times less crops than soil in advanced countries, and according to some sporadic investigations, the soil of India is deficient in nitrogen, phosphorus and potash, and, due to the causes just mentioned, productivity is diminishing year by year.

But why does not the Indian peasant use fertilizers to increase the productivity of the soil, as has been done in other countries? For some reason best known to themselves, neither the Government, nor the Imperial Council of Agricultural Research, has paid

any attention to the fertilizer problem, and no synthetic fertilizer industry has grown up in the country which can deliver to the peasant suitable fertilizers at economic prices. According to Dr. Burns, if India is to attain safety in food production, the yield should increase by 30 per cent, and this needs nearly a million tons of nitrogen in the form of ammonium sulphate and other fertilizers. Many parts of India show unmistakable signs of phosphorus deficiency, but nobody has yet surveyed her total needs in this respect.

In short, a native fertilizer industry is indispensable for greater agricultural production, and this alone will consume a large amount of the electrical energy to be produced. But this is not all.

The Indian agriculturist, like agriculturists in other parts of the world, cannot depend upon food crops alone. He has to raise also cash crops such as cotton, jute, sugar, oil seeds and tobacco, each one of which is useless unless it is utilized industrially. Fortunately, the corresponding industries have developed in India, though there is far more scope in this direction. India has almost none, or few, food-processing industries, and her excellent and wide variety of fruits are on the market only for a limited season. There is a great future in this line, but no food-processing industry can flourish without the refrigeration industry. Further, as Sir Harold Hartley has told us in his Mather Lecture, agriculture and forestry can serve as a potential source of raw materials in scores of industries—such as the manufacture of rayon, paper, plastics, liquid fuel, industrial gases—and the development of all these industries requires cheap power.

There is therefore no inherent antagonism between industry and agriculture, and without development of agricultural industries, the rural population of India can never be pulled out of the dreadful medieval conditions in which they find themselves, breeding a Malthusian population which has been a matter of extreme concern to the rulers. For urbanization means better living, and better living leads to moderate increase of population.

Natural Resources of India

But has India sufficient resources for a balanced development of industries and agriculture on the lines just indicated? According to a competent authority, India, like the United States of America, the U.S.S.R. and China, is one of the few political units of the world which has enough potential resources in power, minerals, and forest and agricultural products, for a balanced development of industry and agriculture to produce *plenty* for her population. The first problem to be tackled is that of power. India has, according to the work carried out by the Geological Survey of India, 60,000 million tons of coal within the first thousand feet of the surface. This is a comparatively small figure compared to the enormous resources of Great Britain and the United States, and most of these deposits are to be found in a small region in eastern India. But she has plenty of 'white coal'—water-power resources—awaiting development. According to a very imperfect survey—or should I say an intelligent guess—carried out nearly twenty years ago by an officer of the Government of India, her water-power resources amount to nearly 20 million* kilowatts, and so far only half a million

* The water-power resources of pre-war Russia were estimated in Czarist days to be 14 million kilowatts. A detailed survey carried out early in the Five-Year Plan pushed up the figure to 280 million kilowatts.

slowatts have been developed. But the figure is probably a gross under-estimate as in the case of the U.S.S.R. The first problem before the Government of India should be, therefore, to carry out an adequate survey of the hydro-electric resources of India, and plan for the development of ample power for industries.

Civilized life in India has, from time immemorial, grown in river-valleys, which have been used for navigation and irrigation. During the British regime, development has been one-sided, namely, for irrigation only, and navigation has been allowed to fall into decay. But both Soviet Russia and the United States of America have, within the last twenty-five years, set a new ideal for river development. We can take, as a typical illustration, the development of the Tennessee River, which before 1933 was a matter of great concern to the Federal Government on account of the destructive floods, soil erosion, and progressive pauperization of dwellers of the valley. But it is now well known, thanks to the initiative of American statesmen, that this river has been completely transformed by the construction of twenty-one dams over the main river and tributaries. These dams serve the multiple purpose of flood-prevention, navigation and power development, and soil erosion has been prevented by auxiliary measures. The hitherto untamed river, instead of being allowed to dissipate its energy in destructive work, is now harnessed and yields 12,000 million units of electrical energy, which is used for great, productive works which have sprung up in the valley (metallurgical, chemical and fertilizer industries).

The multi-purpose development of a river valley, the benefits of which have been so strikingly demonstrated by the Tennessee Valley Authority, is applicable to at least a score of river valleys in India. I have made a particular study of the Damodar Valley, an area of 9,000 square miles, which forms the country to the west of the great city of Calcutta. The lower part of this valley, forming the suburban area of Calcutta, was, a hundred years ago, one of the healthiest regions of the world. But, after the construction of railways from 1850, and great roads to connect Calcutta with upper India, embankments were reinforced and constructed on the left bank of the river in order to protect these highways from the destructive river floods. These embankments have by no means removed the danger to the highways, for in 1943 there was only a moderate flood which breached the line at numerous points, and seriously interfered with traffic to Calcutta at a very critical period of the history of the country. They have, in addition, turned the country into a malarial swamp. Even the safety of Calcutta is endangered.

I have shown by a preliminary study that this valley can be subjected to the same treatment as the Tennessee, and can be developed for energy generation (to the extent of 2,000 million kWh a year), navigation, and flood prevention. The lower valley can be transformed by auxiliary methods of irrigation into a fine suburban area, where the teeming population of Calcutta can expand.

But the Damodar Valley is not unique. The Sone, the rivers of the Deccan (the Kaveri has been developed to some extent), the Mahanadi, the Punjab rivers, and many others too numerous to mention, can be developed according to the T.V.A. methods for the benefit of India's millions.

This is only a cursory survey of the problems of India and of the way in which we have to look at it.

It is regrettable that the Indian leaders have so far paid attention only to the question of political freedom. It is natural that everyone of us should want our country to attain full nationhood and the people have full sovereignty, but the problem of living for millions of Indians cannot be postponed, in fact, we believe that the only way to achieve unity of thought and purpose in the political field, which is now wanting, is first to look at the problem of living for India's millions. To solve this problem successfully there must be a national purpose behind all planning, and I do not see how any planning can be given effect without a National Government, or unless we have a Government which has popular support and is composed of leaders in whom the people have confidence.

ASTRONOMICAL AND GEOPHYSICAL PERIODICITIES

A GEOPHYSICAL Discussion on "Astronomical and Geophysical Periodicities" was held in the rooms of the Royal Astronomical Society on December 8, 1944, the chair was taken by Prof. L. M. Milne-Thomson, and in the absence of Dr. Harold Jeffreys through indisposition, the discussion was opened by Dr. H. R. Hulme.

Dr. Hulme's interest in this problem originally arose in connexion with the reality of the supposed periodical variations in the solar constant. Any time-series of observations can be analysed by the routine method of harmonic analysis, and amplitudes will be obtained which will not in general be zero, even when there is not the slightest reason for suspecting the presence of a periodic variation, such an analysis has, in fact, often been carried out with geophysical data. The first attempt to find a criterion for the reality of a periodic term was made in 1906 by Sir Arthur Schuster, who found that if n independent observations were analysed into their Fourier components the average amplitude ρ of a Fourier coefficient is $2\sigma/n^{1/2}$, where σ is the standard deviation of the n observations, if, then, the observed amplitude is ρ_0 , the chance that such a component could arise purely as a result of random fluctuations is e^{-k} , where $k = \rho_0^2/\rho^2$. Thus, if the amplitude found is more than twice ρ , there is some ground for suspecting that the periodicity may be real.

The Schuster criterion, however, takes no account of internal correlations among the data. Thus a naive view of the problem may give misleading results, if, for example, the observations are subject to disturbances, each of which affects a number of consecutive observations, the effective number of independent observations may be far less than n . Moreover, the criterion is of limited usefulness, since an investigator who thought that the values of a series of observations were all independent of one another would not be likely to make a harmonic analysis of the results. A more searching method of analysing a time-series was given in 1927 by Mr. G. Udny Yule. He considered two types of periodicities: the periodic phenomena where each disturbance affects only the momentary value of the quantity observed, and periodic phenomena in which each disturbance affects all the subsequent values, as, for example, a change of phase. The latter type would be discussed by Mr. M. G. Kendall. Dr. Hulme pointed out that an outstanding problem is to find

how to test whether a given oscillation belongs to one or other of these types

Mr H W Newton stated that more than two hundred years elapsed between the discovery of sunspots and the discovery of their eleven-year periodicity, the success of Schwabe in discovering the eleven-year cycle in 1810 might be attributed to his systematic work and to the fact that he continued his observations over three or four solar cycles. A graph of the frequency of naked-eye sunspots indicates that an observer with a piece of smoked glass making systematic observations like Schwabe could have discovered the eleven-year cycle, it is possible, however, that observers in the seventeenth century may have been frustrated by a 'submergence' of the sunspot cycle. The observed reversal of the polarity of the magnetic field in sunspots suggests that the fundamental period is twenty-two years, this, however, is not obvious from the diagram of many sunspot cycles as measured at Greenwich, though Turner got a difference from spot area data, 1842-1910, nor does it show up in Maunder's famous diagram (the 'butterfly' diagram) of the cyclical change of latitude of sunspots.

The Zurich 'sunspot numbers' from 1750 until 1911 were subjected to a harmonic analysis by Kimura. As in the customary method of predicting tidal heights, Kimura computed the form of the extrapolated curve after 1911, this prediction was not realized, for the time and amplitude of the next following maximum observed in 1917 were in marked disagreement with Kimura's values. Other analyses had been made by Newcomb, Schuster, Yule, Waldmeier and others, the average length of the cycle may be accepted as 11-13 years. Mr Newton emphasized the necessity of using a long series of data in any attempt to establish a periodicity or a correlation, for example, the annual excess of turns of a weather vane at Greenwich, direct over retrograde, had been compared with the sunspot cycle, and it was found, rather surprisingly, that a general parallelism existed for some years. This correspondence, however, did not persist, and the parallelism appeared to be quite fortuitous. In conclusion, Mr Newton showed a diagram of the comparison over thirty years of the monthly sunspot areas and the diurnal inequality ranges in magnitude of the terrestrial magnetic elements D , H and V . The correspondence is very striking, and extends to the details of the curves, later observations confirm the closeness of the correlation, and give values as high as 0.95 for the coefficient of correlation for individual eleven-year cycles.

Mr M G Kendall, in his contribution, explained that although he knew little about astronomy, he believes that many of the oscillatory movements in time series which are found in geophysical and meteorological data possess similar features to those in economic series in which he is primarily interested. In this connexion he wished to direct attention to the large amount of work which is being done on time-series in quite unrelated fields, the necessity for an interchange of information between workers in different branches of science, and some co-ordination of effort.

The classical method of analysing oscillatory movements is to exhibit the series as a sum of harmonic terms. If, as usually happens, observation differs from mathematical representation, the differences, however large, are regarded as errors of observation in the sense that their effect is instantaneous

and does not endure in the future motion of the system. For most practical series, this does not appear to be a plausible hypothesis, because disturbances of the motion, though possibly random in the sense that their occurrence is according to the laws of chance, permanently affect the future motion of the system and are incorporated into it.

The statistical problem is to find a mathematical representation of such a system. The nearest approach to a solution so far advanced was that given in 1927 by Mr Udny Yule in his paper on sunspots. Yule was led to consider a type of series, which has been called 'auto-regressive', in which the value at any point is partly a function of those at previous points, and partly a disturbance function. One simple form of this type of series can be written

$$u_{t+1} + au_t + bu_{t-1} - \varepsilon_{t+1} = 0,$$

where ε_{t+1} is the disturbance, which can in particular cases be random. Mr Kendall has recently constructed a number of artificial series of this type and analysed them by the Schuster periodogram method. The results are very striking. Not only does the periodogram fail to reveal the true nature of the series, but also it suggests quite a large number of periods where none exist. He has come to the conclusion that for series of this type periodogram analysis is not worth the labour of undertaking.

Mr Kendall has also considered the practice of counting peaks in a series as providing an estimate of 'period'. For autoregressive series of the type mentioned, it appears that this is an extremely insensitive method inasmuch as for the majority of values likely to be encountered in practice it will give a value somewhere between 4 or 6 units, whatever the nature of the series. His experimental series and a number of practical economic series do in fact give such values and the appearance of 'periods' of this kind throws very little light on the true nature of the generating process.

Reference was also made by Mr Kendall to the technique introduced by Mr Yule of computing the serial correlations of the series. This appeared to give much more reliable results, but is not without its difficulties. In conclusion, he said that in his view a great deal of the work which has been done on the analysis of oscillatory movements will have to be reconsidered, he is convinced that 90 per cent of the 'periods' which have been claimed by different writers were spurious.

Miss N Carruthers discussed periodicities in weather phenomena. She said that there are some true periodicities, such as, for example, the annual and diurnal variation of most meteorological elements, but it is doubtful whether they are truly represented by combinations of sine curves. In addition to these, spasmodic oscillations are found in most series of meteorological data. Some may be purely random fluctuations, but others have a tendency to reappear at intervals with the same wave-length, although not, in general, with the same phase. The latter most often persist for three or four wave-lengths only, after which they either end abruptly or change phase unexpectedly. Examining meteorological waves (the irregular kind can scarcely be termed periodicities) with Dr C E P Brooks, it had been found that determination by harmonic analysis is unreliable, and a year ago they devised the 'periodoscope' which Miss Carruthers described before the Royal Meteorological Society last June. In this form of analysis, by a simple combination of the terms in a series

containing periodicities, a new series is formed in which these were retained with period and phase unaltered. For periods lying within a pre-assigned range, however, amplitudes are magnified, so that, when the new series is plotted, the corresponding periodicities can be readily identified by eye with the aid of key curves drawn on tracing linen. Examples of waves found by this means in London temperature were contrasted with the more regular sunspot cycle (9–13 years) treated in the same way.

Most waves in meteorological phenomena appear to be natural oscillations of the earth's atmosphere. Haurwitz, Lettau and Defant deduced theoretical periods of 6–57 days, all of which have been found in pressure and some also in rainfall. These, however, are not set up without some external stimulus, just as a violin string does not emit its characteristic note of its own accord. The fragmentary nature of these waves can, likewise, be explained by analogy with a violin string, for if the string receives impulses at intervals incommensurate with its period of vibration, the vibrations break up and change phase abruptly with each fresh impulse. The analogous impulses received by the atmosphere appear to be connected with variations of solar radiation. That these occur at intervals which are not natural periods of atmospheric vibration is indicated by a comparison of prevailing periods in the solar constant and in European pressure.

Solar Constant	75, 51, 37, 25, 19 days
Pressure	72, 48, 36, 24, 18 days

A further illustration is afforded by the 3-year wave in the pressure at Darwin, which has been found by C Braak to break up and change phase about the time of sunspot maximum, this is probably the same as the waves found earlier in India and the Argentine by Sir Norman Lockyer and identified as $3\frac{1}{2}$ -year periodicities.

Other periods indirectly induced by solar radiation are connected with interchange of air between continents and oceans and outbreaks of cold air from the polar regions. The moon induces a semi-diurnal atmospheric tide which is a true periodicity, but it is too small to have any appreciable effect on the weather.

Mr P. M. Ryves summarized the general characteristics of stars the intrinsic luminosity of which is variable, these constitute only a small percentage of the stars observed, but they cover the whole range of spectral classes from *O* to *M* and *N*. Periods range from $1\frac{1}{2}$ hours to 20 years or more, but periodicities of more than two years generally correspond to small amplitude of variation, and are often irregular or uncertain, and frequently complicated with superimposed shorter periods. There is a very definite correlation between length of period and spectral class, the shorter periods corresponding to the hotter early-type stars and long periods to late types. Though variables can be found with periods anywhere between the limits mentioned, a frequency curve shows three prominent peaks, one corresponding to the RR Lyrids with mean period of about half a day, the second to the Cepheids (really a double peak with a minimum at about nine days), and the third, at a little short of 300 days, to the Mira-type and other long-period variables.

Dealing particularly with the long-period variables, Mr Ryves mentioned that typical Mira-type stars have a mean amplitude of about five magnitudes, with spectral class *M*3 to *M*8 (90 per cent), or *N*

(5 per cent) or *S* (5 per cent), all with emission spectrum, and periods for the most part between 150 and 550 days. The magnitude at maximum varies in individual cycles to the extent of one magnitude or more, and the magnitude at minimum also varies, but generally to a smaller extent. The period is frequently irregular in the sense that any given phase may be unpunctual to the extent of 5–10 per cent, but the mean period is fairly constant. Apart from these oscillations about the mean, there are sometimes permanent changes: (a) a sudden change in the length of the period (this has happened more than once in some stars), (b) a discontinuity, or shift in the phase, without change of period. Mira-type stars show a small progression of spectral class with increasing length of period, and also, but with many exceptions, a progression from symmetrical to asymmetrical light curves, and increase in amplitude. The shape of the curve may vary a good deal from cycle to cycle, and there is sometimes a pause or hump as in the sunspot curve, this happens more frequently on the ascending than on the descending branch. In some cases the hump is a more or less permanent feature, and shows up on the mean curve. The variables have large space-motions, and are probably revolving about the centre of the galaxy in highly elliptical orbits.

Parallel with the Mira-type variables is another group of stars comprising the red semi-regular variables and the so-called red irregular variables. The fundamental difference is that these have no emission spectrum, or at most a very faint one, and that the amplitude is much smaller, usually one or two magnitudes. The variation is also less regular, both as regards punctuality and the shape of the light curve. Double maxima, or a tendency for deep and shallow minima to alternate, are common, and a long-term variation in the median magnitude sometimes appears. With irregular variables there may be several maxima at fairly regular intervals, followed by a period of disturbance, after which a new series of maxima appears, quite out of phase with the former series.

Dr R. Stoneley recalled a paper by Dr H. Jeffreys that is extremely relevant to the present discussion. Many harmonic analyses had been made of the occurrence of earthquake shocks, notably by Prof. H. H. Turner and Dr C. Davison. The latter had applied the Schuster criterion to his results, and *prima facie* had found good evidence for the genuineness of a number of the periodicities. Dr Jeffreys found that the existence of internal correlation among the data would increase the random amplitude expected in a Fourier analysis, and would therefore vitiate the direct application of the Schuster criterion. The phenomenon of aftershocks following a large earthquake does imply that all the shocks recorded in a catalogue cannot be treated as random occurrences. In the aftershocks of the Tango earthquake of March 7, 1927, the falling-off of the frequencies of the aftershocks is consistent with a regular law of chance that depends only on the time-interval elapsing since the main shock and a second strong shock on April 1, 1927, but otherwise the aftershock appear to be mutually independent. The amplitude obtained for periodicities superposed on this variation are not such as would give any support for the reality of these periodicities.

As was stated at the beginning of this article Dr Jeffreys was not present at the meeting, but was asked to comment on the above report. He emphas-

izes that the Schuster criterion is the particular case of Pearson's χ^2 test when the number of degrees of freedom is 2. The analysis of the variation of latitude observations shows the same kind of serial correlation as Yule has considered, with the additional complication that the disturbances do not appear to be derived from the normal law. Fortunately, it was possible to find a long interval when there seems to have been little disturbance. In this problem there is an observational error special to each datum and also a real fluctuation the successive values of which are correlated, the method of maximum likelihood can deal easily with either by itself but becomes prohibitively complicated when the two are superposed.

HÆMOGLOBIN IN THE ROOT NODULES OF LEGUMINOUS PLANTS

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THE red pigment in the root nodules of a leguminous plant (*Vicia Faba*) was investigated for the first time by Pietz¹. He believed it to be identical with the red intermediate product which appears during the oxidation of tyrosine or of dihydroxyphenylalanine ('dopa') catalysed by tyrosinase. According to Pietz, the red pigment, by undergoing a reversible reduction, has the function of poising the oxido-reduction potential of the nodule at a level favourable for the proliferation of symbiotic bacteria inhabiting the nodule.

Pietz' conclusion, however, was based not upon the direct study of the pigment, but upon certain considerations derived from the study of oxido-reduction potentials of nutrient media in relation to growth of symbiotic micro-organisms, and the fact that the addition of 'dopa' to the medium favours the growth of these bacteria.

A year later the pigment in the root nodules of a great variety of leguminous plants was reinvestigated by Kubo² both *in situ* and in preparations obtained by fractionation of an extract of nodules with ammonium sulphate. He examined the pigment spectroscopically and determined the position of its absorption bands under different conditions. Thus when aerated, the pigment shows two absorption bands, at 575 m μ and 540 m μ , which, on reduction with sodium hyposulphite, are replaced by one band at 555 m μ . In the presence of carbon monoxide the bands are shifted to 570 m μ and 535 m μ , and on treating the pigment with potassium ferricyanide a compound is obtained with three absorption bands, at 625 m μ , 563 m μ and 530 m μ . This latter compound was found by Kubo to react with cyanide, fluoride and peroxide. Finally he obtained from this pigment crystals of haemin indistinguishable from protohaemin. As the result of these observations, Kubo concluded that the red pigment of the nodules is a haemoprotein compound analogous to haemoglobin and acting as a store as well as a carrier of oxygen.

More recently, the nature of this pigment was

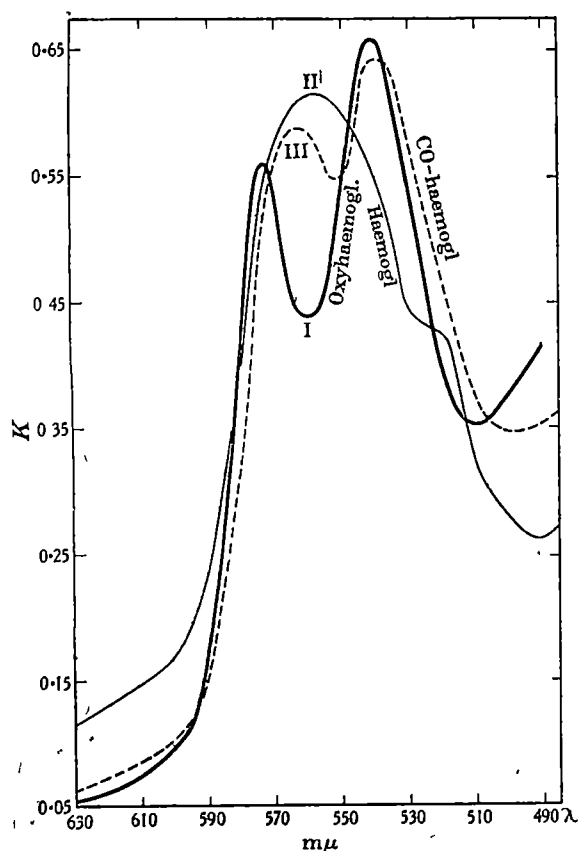
reinvestigated by Burris and Haas³ on the material obtained from root nodules of cow-peas (*Vigna sinensis*) fractionated with ammonium sulphate. The light absorption of the pigment thus obtained showed a strong γ -band at 405 m μ characteristic of haematin compounds and in the visible region one band only at 530 m μ instead of the two bands described by Kubo. They also found that after "deoxygenation of the solution the spectrum of the oxidized form remains unchanged, indicating true oxidation and not merely oxygenation of the red pigment". On reduction with sodium hyposulphite the γ -band moved to 430 m μ and the band in the visible region was replaced by one at 560 m μ . Burris and Haas agree with Kubo that the pigment is a haemin compound, but, contrary to his views, they think that its "behaviour towards oxygen indicates that it is not a haemoglobin-like substance".

The results of the work summarized above leave no doubt that the red pigment in the root nodules of leguminous plants is a haematin compound and not a quinone as was postulated by Pietz. The object of the present investigation was to determine whether the pigment is an oxygen carrier of the haemoglobin type which combines reversibly with molecular oxygen, or whether it is an oxidation catalyst which, like the components of cytochrome, undergoes a reversible oxido-reduction accompanied by valency changes of the haematin iron.

Although we have examined the nodules of a number of leguminous plants, the material we have used for this study was mainly the root nodules of the soya bean. The pigment was studied either directly in nodules compressed between two slides or as extracts of nodules purified by fractional precipitation with ammonium sulphate.

The position of the absorption bands of this pigment and of its derivatives was determined with the microspectroscope, and the absorption spectra were determined with the Hilger-Nutting spectrophotometer. This was done only for the visible region of the spectrum, since haematin derivatives are more readily differentiated by the absorption bands in this region than by their γ -bands.

One of the main difficulties in the extraction of this pigment from nodules, which have to be crushed for this purpose, is the more or less rapid darkening of the pulp and of the extract due to oxidation of a phenolic substance catalysed by the phenol oxidase. The quinone formed during this reaction oxidizes the iron of the pigment and partly denatures its protein, whereas the melanine which is ultimately formed adsorbs the pigment and masks its colour and its absorption spectrum. However, one can overcome these difficulties in several ways. Thus, by crushing the nodules in saturated ammonium sulphate and washing the pulp in the same solution, the phenoloxidase can be precipitated before it has time to act upon the substrate, which can be afterwards removed. At the same time we have added an excess of sodium azide which poisons phenolase and a small amount of sodium hyposulphite which also prevents the oxidation of the substrate and keeps the iron of the pigment in the reduced state. The reduced state can be more efficiently stabilized by saturating the solution during different manipulations with carbon monoxide. Under these conditions the extracts can easily be fractionated with ammonium sulphate, and the fraction between 65 per cent and 84 per cent saturation, which contains most of the red pigment, is collected.



ABSORPTION CURVES OF HÆMOGLOBIN FROM ROOT NODULES OF SOYA BEAN

I, Oxyhaemoglobin (prep A), II, deoxygenated haemoglobin (prep B), III, carbon monoxide-haemoglobin (prep B), extinction coefficient $k = \frac{1}{l} \log_{10} \frac{I_0}{I}$, Preparation A contains probably small concentration of methaemoglobin. Concentration of haemin per 100 ml in preparation A = 4.05 mgm., in preparation B = 3.46 mgm. Preparations A and B are of different degrees of purity and probably contain a small amount of haematin not belonging to haemoglobin.

The haemin content of this preparation, estimated spectroscopically as pyridine haemochromogen, was found to be approximately 2 per cent of its dry weight. If we assume that the total haematin found belongs to the undenatured red pigment and that its haematin content is approximately the same as that of haemoglobin, the purity of our preparation would be 40–50 per cent. Preparations of this purity were found to be quite suitable for the study of the main properties of the pigment.

Properties and Nature of the Pigment A solution of this pigment is deep red and its absorption spectrum shows two distinct bands with the maxima at about α -574 mμ and β -540 mμ, the α -band being narrower and lower than the β -band (Curve I).

On treating the solution with sodium hyposulphite, the two bands disappear and are replaced by one band with the maximum at 557 mμ (Curve II). What is more remarkable, however, is that this change can be obtained in the absence of a reducing agent by warming the solution in a Thunberg tube to about 37° C and evacuating the tube with an ordinary water pump. After boiling for a few minutes the two bands gradually fade away, being replaced by a single band at 557 mμ. On opening the tube and shaking the solution with air, the two-banded absorption spectrum rapidly reappears.

All this clearly shows that the two-banded spectrum belongs to the oxygenated and not the oxidized state of the pigment. Like haemoglobin, the pigment of root nodules forms with molecular oxygen a loose and perfectly reversible compound. That the iron of this compound, like that of oxyhaemoglobin, is in a divalent state is shown by its reaction with carbon monoxide, and with potassium ferricyanide. On treating the oxygenated compound with carbon monoxide, its two absorption bands are replaced by two more diffuse bands lying at 564 mμ and 538 mμ (Curve III). The addition of potassium ferricyanide to the oxygenated compound changes its colour from red to brown, and its two absorption bands are replaced by the absorption spectrum characteristic of methaemoglobin.

The failure of Burris and Haas³ to recognize the true nature of this pigment was probably due to the fact that their preparation contained mainly the methaemoglobin derivative with its band at 530 mμ as described by Kubo. Had they dialysed against water a sample of their preparation treated with sodium hyposulphite, they would probably have noticed the appearance of the oxygenated compound with its two characteristic absorption bands.

The affinity of this haemoglobin for oxygen expressed as oxygen tension in mm mercury which corresponds to 50 per cent dissociation of the oxygenated compound was determined spectroscopically at 15° C and was found to be less than 0.1 mm. The relative affinity of this pigment for oxygen and for carbon monoxide, expressed as the equilibrium

$$\text{constant } k = \frac{(\text{HbCO}) (p\text{O}_2)}{(\text{HbO}_2) (p\text{CO})}$$

was determined spectrophotometrically at 15° C and its value was found to be about 37. It is somewhat higher than the value obtained for myoglobin, but considerably lower than the values found for mammalian blood haemoglobin. These values should be considered as approximate only, since they have been obtained on samples which were only about 50 per cent pure. They may require a certain correction when the pigment is obtained in a purer form.

That the haemoglobin is in some way connected with the nitrogen fixation by nodules seems to be supported by two facts. (1) its constant presence in nodules of every leguminous plant so far examined; and (2) the inhibition of nitrogen fixation by a very low partial pressure of carbon monoxide⁴. At such pressures carbon monoxide is known to react mainly with haemoglobin. However, it is difficult to ascribe to this haemoglobin any definite function, since the mechanism of nitrogen fixation by nodules is far from being elucidated⁵, moreover, the function of haemoglobin even in certain invertebrates is not yet properly understood.

General Considerations The presence of haemoglobin in root nodules of leguminous plants is of great general interest. It is well known that in animals, outside vertebrates, haemoglobin has a very irregular distribution, being either completely absent in all representatives of large phyla of invertebrates, or present in only a very few species of a phylum while absent in all other, often nearly allied, forms. Since, however, all cells of aerobic organisms, including bacteria and plants, are capable of synthesizing haematin catalysts such as the components of cytochrome, obviously every cell can be considered as a potential carrier of the prosthetic group of haemoglobin. The limiting factor in the distribution of haemoglobin in Nature is the ability of cells to

synthesize the highly specific proteins which, when combined with haem, impart to it the remarkable property of reversible oxygenation. This property, which haemoglobin shares with only a few natural oxygen carriers, has no analogy among chemical compounds.

The root nodule haemoglobin represents the first case of the occurrence of this pigment in plants, although other haematin compounds such as cytochrome peroxidase and catalase are known in plants. What is, however, more interesting is that neither the plant cells alone nor the symbiotic micro-organisms (*Rhizobium*) cultivated separately are capable of synthesizing haemoglobin. It is only when the root cells are invaded by specific symbiotic micro-organisms and begin to proliferate that haemoglobin is formed. *Rhizobium* not only induces growth and multiplication of cells, but also supplies these proliferating cells directly or indirectly with a factor necessary for synthesis of haemoglobin.

For the plant material used in the present investigation we wish to thank Dr H. Hunter, Mr E. G. Thompson, Prof. E. J. Salisbury and Dr Kenneth M. Smith. This work was assisted by a personal grant from the Medical Research Council to one of us (Y. L. W.).

¹ Pietz, J., *Z. Bakt.*, (2), 99, 1 (1938).

² Kubo, H., *Acta Phytochem.*, 11, 195 (1939).

³ Burris, R. M., and Haas, E., *J. Biol. Chem.*, 155, 227 (1944).

⁴ Wilson, P. W., *Ergeb. Enzymfor.*, 8, 13 (1939).

⁵ Wilson, P. W., "The Biochemistry of Symbiotic Nitrogen Fixation" (Madison: The University of Wisconsin Press, 1940).

RUSSIAN RUBBER PLANTS

IN recent years there has been a great deal of interest in the study of rubber-bearing plants that will grow in temperate and sub-temperate climates in connexion with the possibility of establishing sources of supply of natural rubber independent of the tropics. Russian workers have been the pioneers in this field, and it is in the U.S.S.R. that the most noteworthy developments have taken place. The published accounts of this work (mainly in Russian) are unfortunately difficult of access, especially at the present time. It is fitting, therefore, that a comprehensive summary (in English) should now have appeared, with special emphasis on what is so far known of the genetics of the plants concerned and what breeding work has so far been carried out with them*.

A brief history is given of the search for rubber-bearing plants in the U.S.S.R. which first began during the War of 1914-18 and of the expeditions that have been arranged for the purpose. Since that time, several thousand species have been examined, and special methods evolved for detecting the presence of rubber both qualitatively and quantitatively. Apart from latex-bearing plants, many species were found to contain rubber in the mesophyll tissue of the leaves, but successful extraction presented many difficulties. The most promising rubber-bearing plants outside the tropics were found to be those containing coagulated rubber in the roots and underground stems. In these plants the rubber, often visible as strands, was found to be more easily separated from the surrounding tissue than was the

case where the rubber occurred in the leaves. Furthermore, it was found to have a markedly lower resin content.

The first plant of this class to show promise as a possible commercial source of rubber, if cultivated, was tau-saghyz (*Scorzonera tau-saghyz*), discovered in 1929 on the Kara-Tau mountains of Central Asia. Several forms or ecotypes of the plant are now known to exist. A good account of the plant is given, its growth characteristics and its behaviour under cultivation. Although possessing a good rubber content in the root, the plant proved susceptible to disease and difficult to cultivate satisfactorily in most areas. For this reason it gave way to other rubber-bearing species brought to light a few years later, which proved to be better subjects under cultivation, such as krim-saghyz (*Taraxacum megalorrhizon*) and kok-saghyz (*Taraxacum kok-saghyz*).

Both these plants are very similar to the ordinary dandelion in general appearance and possess large, rather fleshy roots in which the rubber is chiefly located. Kok-saghyz is the more hardy plant and may be cultivated over a much wider area of the U.S.S.R. than krim-saghyz. The latter occurs wild in the Crimea region and is liable to be killed in winter except in places where winter conditions are relatively mild. It is for this reason that interest is now centred mainly on kok-saghyz, and the area devoted to it is the largest of all the areas in which rubber-bearing plants are now grown. The plant is usually cultivated in districts where the annual rainfall is not less than 450-500 mm and thrives particularly in the central part of the U.S.S.R., as in the Orel and Ivanov territories and in the Ukraine and White Russia, also in irrigated lands in Central Asia. It has been grown as far north as the Kotlas region of the Archangel territory. The plant thrives and gives the best yields on low-lying alluvial land, especially good peaty and humus soils and in particular those that have been well manured. In White Russia, experiments have shown that on peaty soils larger yields of roots with higher rubber content have been obtained than has been found possible on mineral soils. For high yields of root, deep, fertile, friable soils rich in nutrients and with adequate moisture are necessary. Structureless soils, which rain turns into mud and which lack nutrients, or sandy soils, are regarded as unsuitable for kok-saghyz.

A good account is given of the methods adopted in the field cultivation of kok-saghyz from the sowing of the seed to the harvesting of the roots. As germination of the seeds is naturally poor or uneven, pre-treatment or vernalization is often necessary. The seedlings are also somewhat delicate and slow-growing. They are easily choked or smothered by weeds in the early stages. For these reasons the crop is a more difficult one to raise than many field crops. Special machinery has had to be devised for dealing with the crop, particularly in sowing the seed, harvesting the roots and in the collection of seed, which is similar to that of the dandelion and dispersed by wind almost as soon as it is ripe.

Propagation by means of root fragments, which is possible with the plant if certain precautions are taken (as recommended by Lysenko), should offer interesting possibilities, but so far does not appear to have progressed beyond the experimental stage. Pieces of the root 1-2 cm. long cut off in the early spring and allowed to callus in moist sand and planted in place of seed make much more rapid growth than seedlings, and when a few days old

* Cultivation and Breeding of Russian Rubber-Bearing Plants: Imperial Bureau of Plant Breeding and Genetics, Cambridge, and Horticulture and Plantation Crops, East Malling, England. 2s. 6d.

resemble seedlings two months old. This simplifies weeding. Another obvious advantage is that high-yielding individual plants may be rapidly propagated vegetatively in this way. A drawback of this method for large-scale or field planting, according to Mynbaevdel, is that the development of the main root is retarded.

Various insects are known to attack the kok-saghyz plant in different stages of its development, and a good account of these is given. With regard to soil pests the chief of these in the more northerly regions is the wireworm. Cockchafer larvae, which gnaw through the roots at various depths, may also be troublesome.

Genetical work that has been done on certain other rubber-yielding plants in the U.S.S.R. in addition to the above is also reviewed. These include species of *Asclepias*, *Apocynum*, *Solidago* (golden rod), *Scorzonera*, *Chrysothamnus*, *Parthenium* (guayule) and *Taraxacum*. Each genus is treated in a separate section, and information is given under the headings of A, Taxonomy and Distribution, B, Cytology and Reproduction, C, Variation and Genetics, and D, Breeding. Guayule and the species of *Taraxacum* have received most attention, as might be expected in view of the fact that they have shown most promise as rubber producers.

With regard to guayule the opinion is expressed that the breeding stocks in the U.S.S.R. and in the United States differ considerably in their potentialities and that the Russian are inferior to the American. This is not surprising when it is considered that the American breeders have had continuous access to wild material while the Russians have had to develop their strains from a single collection. The fact that the development of American varieties was monopolized by a private firm until recently (1942) has probably discouraged other breeders from investigating guayule. Improvement with guayule has been effected mainly by selection, rather than by hybridization, which is difficult. Strains yielding as much as 22 per cent rubber are now available, and there has been some improvement in plant-size but little in accelerating the growth-rate, plants being normally harvested in their third or fourth year.

Cytologists may be interested in the remarks regarding the genus *Scorzonera*, particularly tau-saghyz, in connexion with which it is stated "The diploid chromosome number is 14 and each chromosome has a distinctive morphology, they are all two-armed, 2 pairs having median centromeres and 5 pairs sub-terminal centromeres. It has been found that two races of the species exist, each distinguished by its own chromosomal morphology. In one race, satellites are present in three of the chromosome pairs, one of which is heterozygous for a second satellite. In the second race, satellites are completely absent. Examinations of the root tips of *S. tau-saghyz* have revealed rather a complicated picture of chimaeral polyploidy and aneuploidy. Triploid, tetraploid and hexaploid cells have been discovered both in the peribem and the plerome together with aneuploid cells with 15, 16, 18, 19, 20 or 21 chromosomes. It is assumed that these various anomalous chromosome numbers arise by somatic non-disjunction or chromosome elimination. Trisomic cells have been observed in *S. nervosa* ($2n = 12$) but not in other species of the genus. Chromosome numbers of some other species are as follows: *S. hispanica* ($2n = 14$), *S. acanthoclada* ($2n = 14$) and *S. tuberosa* ($2n = 12$).

"Meiotic behaviour in *S. tau-saghyz* is aberrant,

and the following abnormalities have been observed: lagging chromosomes, adventitious nuclei, chromosome fragmentation, elimination of chromosomes from the spindle, polynucleate pollen and viable pollen with aneuploid chromosome numbers. It has been found however by Poddubnaja-Arnoldi, Steschina and Sosnovetz (1935) that gametogenesis is regular and that subsequent irregularities, which affect both the megaspores and the pollen grains, are due to the low temperature and high humidity of the plant's normal environment."

In the breeding of tau-saghyz the importance of selecting plants for vegetative vigour is stressed, for the mortality-rate of unselected plants may be very high and reach 100 per cent. The fact that tau-saghyz is very susceptible to disease may, it is thought, be correlated with the scanty soil microflora in its native habitat. The advantages that might accrue from hybridizing tau-saghyz with the vegetable scorzonera (*Scorzonera hispanica*), which has been so long in cultivation and has vigour and a stout root, are emphasized.

Investigations of the cytology of kok-saghyz have been made by a number of workers. "There are eight pairs of chromosomes one of which has satellites attached. Meiosis is normal both in pollen grains and ovules and nearly 100 per cent pollen fertility is reported. The pollen is viable for five days, and fertilization takes place in 15–20 minutes, according to Poddubnaja-Arnoldi and Dianova and 30 minutes at 70° F according to Warmke. The embryo-sac usually develops from the chalazal megaspore. A high degree of self-sterility is usual although some 'end season fertility' is reported from America; the cause of this is obscure and the possible effects of temperature, light and the age of the plant have been suggested. Cross-pollination, which seldom occurs naturally if insect visitors are excluded, produces 100% fertilization. The fertilized embryo develops normally although supernumerary eggs and sperms are formed quite frequently. It is possible that functional polyspermy may occur occasionally in the endosperm but only triploid nuclei have been observed up to the present. There is no evidence of apomixis in this species and it is regarded as extremely improbable."

Crosses have been made between kok-saghyz and about half a dozen other species of *Taraxacum*. "The hybrids are very highly sterile, normal meiosis occurs but is followed by subsequent degeneration of the gametes or the embryo. In the latter case irregular nuclear fusions were observed in the early developmental stages. Koroleva (1939) managed to produce an F_2 and F_3 from the cross *T. kok-saghyz* × *T. multiscaposum* by back crossing with the former species."

It is interesting to note that seed of three of the rubber plants here dealt with (tau-, krim- and kok-saghyz) was obtained from the U.S.S.R. a few years ago and small trials carried out at the Royal Botanic Gardens, Kew, and in various parts of the British Isles. Tau-saghyz appeared to be quite unsuited to the climate, but plants of kok-saghyz and krim-saghyz were raised successfully at several centres and good-quality rubber extracted, but only on a laboratory scale. With all these plants yields are very much inferior to those obtained with *Hevea* on plantation rubber. From the point of view of world economy they may be of comparatively little value and it is only when self-sufficiency is desired that they become of general economic importance.

NEWS and VIEWS

Chair of Logic and Metaphysics at Edinburgh
Prof. N. Kemp Smith

FOR more than a century, largely on account of the eminence of its occupants, the chair of logic and metaphysics in the University of Edinburgh has been very generally, although quite unofficially, regarded as Scotland's premier philosophical chair. Since 1836 there have been four occupants, Sir William Hamilton (1836-1856), Campbell Fraser (1856-1891), Pringle-Pattison (1891-1919) and Norman Kemp Smith from 1919 to the end of the present academic session, when he retires. All four were celebrated for their mastery of the history of ideas, particularly in the eighteenth century and around it. Sir William Hamilton by work which, nominally at least, took its origin from Thomas Reid, Fraser by his unwearying labours on Berkeley, Pringle-Pattison by his dominant neo-Kantianism, and Kemp Smith by his massive study of Kant and of Hume. It is not very reckless to suggest that the last of the four professors surpassed all the others in this common tradition. Our standards in this field are very much higher in the present century than in the last, and only partially because the last had done so much. The intensive study of Kant which is so marked a feature of contemporary British academic philosophy owes more to Kemp Smith's "Commentary" than to the pen of any other English-writing author. His work on Hume, beginning with two masterly articles in *Mind* (1905), and continued in his edition of Hume's "Dialogues" (1935) has (perhaps) concluded with his "Philosophy of David Hume", a book which outstripped all other contemporary work on Hume, British or foreign, by a very comfortable margin. Kemp Smith brought to his classroom the high qualities that he showed in his writings, and all his varied contacts with students, colleagues and the public gained, in addition, from his broad humanity, his deep interest in the social problems of the present day and his catholic appetite for modern history and biography. He knew the United States well, for he was professor in Princeton between 1906 and his return to Europe to serve in the Ministry of Information during the War of 1914-18, and, in 1923, he was a visiting professor in Berkeley, California. A friend to both sides of the Atlantic, he was, is, and, one hopes, will long continue to be, one of the strongest links in the chain of Anglo-American unity and understanding in academic affairs.

Prof. A. D. Ritchie

IN inviting Prof. A. D. Ritchie, at present professor of philosophy in the University of Manchester, to succeed Prof. Kemp Smith, the electors have shown courageous readiness to avoid too rigid an adherence even to a tradition so firmly established, for Prof. Ritchie, who has accepted the invitation, is as much a man of science as a philosopher. They may, indeed, be renewing the tradition. Sir William Hamilton, among his many pre-professorial activities, had studied medicine and had qualified for the Bar. Superficially, however, there is something like a break in the tradition. Prof. Ritchie's principal philosophical books are about scientific method and the natural history of mind. His other book deals with the comparative physiology of muscular tissue. His fellowship at Trinity College, Cambridge, was earned for his work in chemistry, and he was a

lecturer on chemical physiology in Manchester before succeeding J. L. Stocks in the chair of philosophy there. Some may think that first-hand acquaintance with the inferences of experimental science, accompanied by writing upon its general theory, is the best possible preparation for the teaching of logic. As for philosophy in a wider sense, including metaphysics, Prof. Ritchie's varied articles upon many themes, religion and sociology among them, give ample evidence of his interest and capacity. He began, too, in a very favourable environment, his father, D. G. Ritchie, professor of logic in the University of St. Andrews, though he died rather young, being still gratefully remembered as the most brilliant writer among Scottish philosophers at about the turn of the century.

Alexei Abrikosov

ALEXEI ABRIKOSOV has been awarded the title of Hero of Socialist Labour by the Government of the U.S.S.R. Prof. Abrikosov has just celebrated his seventieth birthday. He is a leading specialist in pathological anatomy. He has been successful in combining a theoretical subject with the practical work of a clinic, and was the founder of a new anatomico-clinical branch of pathological anatomy. At the very beginning of his career, Prof. Abrikosov studied the relationships between disease-bearing micro-organisms and the protective powers which the human organism possesses. Allergy, one of the complex problems which arise from this, naturally attracted his attention. He has carried out extensive research on the morphology of the vegetative nervous system and its pathological condition. Applying methods of pathological anatomy, he has made a detailed study of the morphological changes which take place in the tissue as a result of metabolic disorders, avitaminosis and hypo-vitaminosis. For many years Prof. Abrikosov was at the Botkin Hospital, one of the largest in Moscow, and for twenty-five years has held the chair of pathological anatomy at the First Moscow Medical Institute. He was awarded a Stalin Prize for the two volumes already published of a work on pathological anatomy. Prof. Abrikosov still continues active research and teaching.

Research Development and Tax Relief

IN his Budget speech last year, the Chancellor of the Exchequer undertook to provide reliefs of income tax for industry and agriculture during the reconstruction period after the War. A Bill to give effect to these proposals has now been introduced in the House of Commons. So far as scientific research is concerned the allowance given in the Finance Act 1944 (see *Nature*, May 6, 1944, p. 542) is now to be extended to payments made after April 6, 1944. An allowance is also to be made for expenditure for buildings, plant and machinery for research incurred after January 1, 1937. Other proposals are concerned more directly with industry. Allowances are to be made for second-hand as well as new plant. A welcome sense of the well-being of personnel is shown by the inclusion, among industrial buildings, qualifying for allowances, of those concerned with welfare, such as sports pavilions. An annual allowance for a period of years is proposed in respect of capital expended on purchasing patent rights after "the appointed day", and a corresponding charge is to be made against vendors of a patent. Agricultural buildings and works will qualify for allowances,

as will also houses built for workers at mines or oil wells which will be useless when the mines or wells are exhausted. The new allowances will apply to expenditure incurred since April 1, 1944.

University of Birmingham

Among other matters dealt with by Dr Raymond Priestley, vice-chancellor of the University of Birmingham, in his annual report to the Court of Governors, is the part to be played by the universities in making possible the great increase of exports of Britain which will be a vital necessity for us in the post-war world, when a premium will be put on industrial efficiency in every field. One contribution is through the production of an increased flow of engineering graduates of the finest possible quality, from among whom will be found not only the professional engineers of the next generation but also men to fill high executive positions in industry. With this object the University of Birmingham is seeking to rebuild and re-equip its Departments of Mechanical and Electrical Engineering. The private appeal to local firms last year for £250,000 has already met with a gratifying response. No specialization can be admitted in the undergraduate stage, though fundamental work in the University engineering laboratories must be supplemented by vacation courses in industry itself. Nevertheless, something more than this preparation is needed by those among our best engineers whose aptitude and potential capacity attract them to administrative and managerial functions.

A gift from Messrs Joseph Lucas, Ltd., of £112,000, under a seven-year covenant, for the establishment and maintenance of a chair and University lectureship in production engineering, gives a prospect of meeting the need. The University of Birmingham, which serves an area containing the largest concentration of the engineering and metal-working industries in the United Kingdom, is in every way suited to be the home of this development, and the University has agreed to institute a postgraduate course in production engineering, at present to be contained in the Department of Mechanical Engineering. The objects of the new development are to foster through research the full development of every aspect of the science of production engineering and the education through special postgraduate courses of a supply of men who possess not only a sound grasp of the fundamentals of engineering but also a specialized knowledge of production methods and processes and the varied aspects of organization and control. Such a course considerably lengthens the period of engineering education in these special cases, and problems of maintenance of students will be involved. To finance this aspect of the scheme through the first few years, Sir Peter Bennett has generously given £10,000.

Development of the Oil Industry

At a meeting of the Manchester University Branch of the Association of Scientific Workers on February 1, Dr H. Steiner gave a lecture on the development of the oil industry. Oil was first produced industrially in 1859, when 300,000 gallons were obtained, by 1938 the production of crude oil had risen to 70,000 million gallons. In the last century the most important product was kerosene, since 1900 the advent of the motor-car has shifted the importance to the lighter fractions of the crude—mainly petrol. Due to the increased demand for the light fraction, production became unbalanced, in that too much high-

and too little low-boiling fractions were produced. This was remedied by the cracking process, which by applying heat and pressure, produces lower boiling hydrocarbons from the higher boiling ones.

Later, the demand arose for high-quality petrol for improved automobile- and particularly aero-engines. Branched-chain paraffins were produced which are more resistant to 'knocking' than straight chains and can be used in engines working at high compression and thus high efficiency. The first branched-chain paraffin produced commercially was 'iso-octane' (2-2-4 trimethylpentane). This is made from *iso*-butylene, a constituent of the cracking gases. To-day very large amounts of branched-chain paraffins are produced from these gases by combining *iso*-paraffins such as *isobutane* and olefines (for example, butene) in the 'alkylation reaction'.

A later development to produce high-quality petrol is cracking in the presence of catalysts, which assist in forming branched-chain hydrocarbons. The main technical difficulty is that, in the course of the reaction, carbon is deposited on the catalyst and destroys its activity. By burning off the carbon under carefully controlled conditions, avoiding overheating, the activity can be restored. The most recent method employs so-called 'fluid catalysts', that is, very fine powders, which are dispersed in the hydrocarbon vapours and then passed through the reactors. On emerging from the reactors the catalyst is separated, dispersed in air and then passed through a second heated zone where the carbon deposits are burned off. It is then ready to be used again. A very important development is the production of chemicals from petroleum, mainly from the cracking gases. Finally, probably the most important synthesis is that of butadiene. Of about 600,000 tons required for the United States synthetic rubber programme, about 400,000 tons are made from petroleum, mainly by the dehydrogenation of butene over catalysts at high temperatures.

Animal Concealment and Flash Coloration

MOMENTARY display by animals of conspicuous colours followed by reliance upon procrypsis has long been known. Jenner Weir (*Trans Ent Soc Lond*, 22, 1869) directed attention to the conspicuous hind wings exhibited in flight by many otherwise cryptic moths and *Oedipoda* grasshoppers, and Lord Walsingham, in 1890 (*Proc Ent Soc Lond*, 52, 1890), suggested that the sudden change when such flying insects came to rest serves to confuse the visual impressions of a pursuing enemy. H. B. Cott, in his work "Adaptive Coloration in Animals" (1940) devoted several pages and many figures to this 'flash coloration'. An interesting new example of the principle has been described in a letter from Staff Sergeant J. E. Marson (6th (East Africa) Inf Bde Workshops, E. A. F. M. E., South-East Asia Command). "In Ceylon I have noted the effectiveness of the same principle as applied to certain species of spiders. The female of *Herenina ornatissima* (Doleschall) is a medium-sized spider, grey and brown above, with the underside of the abdomen and cephalothorax having brilliant yellow, orange or red markings according to the maturity of the spider. It spins its web on rubber trees, from stumps of branches to the main trunk. The web is nine inches to a foot in length, and is very close to the trunk at all parts. The centre of the web is tubular and is fastened to the trunk by the tip of the tube. In this tubular depression, the female rests, almost perfectly camouflaged."

aged by the similarity of colour to the lichens which grow on the tree. If the spider is disturbed, however, a vivid red streak shoots down the trunk, as it jumps and lowers itself on a thread. The red streak stops as it alights further down the trunk with the underside of the abdomen covered. It is very difficult to follow the later part of this movement, owing to the rapid colour change. Many members of the *Eresidae*, which retreat into their tube-like web endings when disturbed, jump when further attacked, and the same effect is produced by the highly coloured underside of the abdomen. It would appear that this colour change would once again offer protection against a predator attacking at close range."

Parliamentary and Scientific Committee

THE annual report for 1944 of the Parliamentary and Scientific Committee refers to a further increase in the subscribing membership and to the formation of a Parliamentary Action Sub-Committee, which was especially active in connexion with the Finance Bill clauses relating to research. The report includes a summary of the changes recommended by the Sub-Committee on Taxation and Research and of the proposals of Sir John Anderson in his Budget speech last April, as well as of points made to elucidate these proposals during the debate. The principal recommendations in the report on Scientific Aspects of British Agricultural Policy and in the Memorandum on the Organisation and Development of Research in Great Britain issued by the Committee during the year are detailed in the report, which further refers to the preparation of a confidential memorandum on scientific attachés; and to steps taken to encourage the establishment in the Dominions of committees similar to the Parliamentary and Scientific Committee.

γ-Rays in Engineering and Industry

A PAPER on this subject read before the Institution of Electrical Engineers in London on February 1 by Dr V. E. Pullin outlines the development of X-radiography in industry and engineering from the time of Röntgen's discovery in 1895. In the first section, developments in uses and equipment up to the beginning of the present War are recorded in broad outline. In the second, the war-time development of engineering and industrial radiography, particularly with regard to Service requirements and inspection, is dealt with. The third section forecasts future radiographic developments in connexion with modifications in engineering inspection and development. The author also foreshadows the trend of development in X-ray apparatus and equipment. Applications of X-ray crystal analysis in industry and the enormous progress made by radiology in the medical and surgical fields are not discussed.

The Night Sky in March

New moon occurs on March 14d 03h 51m, UT, and full moon on March 28d 17h 44m. The following conjunctions with the moon take place: March 11d 21h, Mars 2° N, March 16d 10h, Venus 12° N, March 21d 03h, Saturn 0.4° N, March 27d 05h, Jupiter 3° S. During March no occultations of stars brighter than magnitude 6 take place. Mercury is close to the sun at the beginning of the month, rising about 20 minutes after, and setting 10 minutes before, the sun then. At the end of March the times of rising and setting are 5h 47m

and 20h 09m, respectively. The planet attains its greatest easterly elongation on March 26. Venus is a very conspicuous object in the western sky and is well placed for observation, setting at 21h 54m and 21h 04m at the beginning and the end of the month, respectively. Venus attains its greatest brilliancy on March 10. Mars, a morning star, is too close to the sun for favourable observation. Jupiter moves from the constellation of Virgo into the constellation of Leo during March, and can be seen throughout the night, setting at 7h 26m and 5h 17m on March 1 and March 31. The planet is in opposition to the sun on March 13. Saturn, in the constellation of Gemini, sets at 3h 47m and 1h 53m on March 1 and March 31, and is stationary on March 5. Vernal equinox is on March 21d 00h.

Announcements

THE Committee of the Athenæum has elected the following, under the provisions of Rule II of the Club, which empowers the annual election by the Committee of a certain number of persons of distinguished eminence in science, literature or the arts, or for their public services: Prof. Sydney Chapman, chief professor of mathematics, University of London; Sir Reginald Coupland, Beit professor of Colonial history, University of Oxford; Sir George Stapledon, director of the Grassland Improvement Station, Ministry of Agriculture and Fisheries, Stratford-on-Avon.

Dr T. McKeown has been appointed to the chair of social medicine in the University of Birmingham. Dr McKeown, a former Rhodes scholar, has been demonstrator in biochemistry at McGill University, Poulton research scholar and demonstrator in physiology at Guy's Hospital, London, and research worker in charge of Field Social and Economic Survey, Research and Experiments Department, Ministry of Home Security.

THE Board of the Institute of Physics has authorized the formation of a South Wales Branch of the Institute which is to be centred at Swansea. The inaugural meeting of the Branch will take place at 2.30 p.m. on March 10 in the Physics Department of University College, Swansea, when Dr C. Sykes, principal of the Brown-Firth Research Laboratories, Sheffield, will deliver an illustrated lecture on "Physics in Metallurgy". Visitors will be welcome; admission is free and without ticket. Further particulars of the Branch can be obtained from the Acting Honorary Secretary, Dr T. V. I. Starkey, Technical College, Mount Pleasant, Swansea.

UNDER the title of "Medical Miscellany Last K", Schuman's, of 20 East 70th Street, New York, has recently published an annotated catalogue of more than seven hundred items on various medical subjects and an appendix with more than a hundred and fifty early American inaugural theses. While all branches of medicine are represented, the subjects chiefly dealt with are anatomy, biography, epidemiology, materia medica, history of medicine, neurology and psychiatry, pathology, physiology, surgery and therapeutics. Special mention may be made of the following books: Charles Etienne's work on anatomy (1545), a French translation of Fracastorius' poem on syphilis (1753), Stephen Hales' "Statical Essays" (1731), Florence Nightingale's "Notes on Nursing" (1860) and Allwoerden's "Life of Servetus" (1728).

LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications.

The Ageing of Light

RED-SHIFTS in the spectra of the galaxies are usually interpreted as Doppler effects consequent on recession. Alternatively, they have been interpreted as an 'ageing' of light with time, by which the wave-length of a photon steadily increases. That the two interpretations are substantially equivalent can be seen from the following strikingly simple calculation. I adopt the kinematic model of the expanding universe.

Suppose a photon has left our own galaxy at epoch t_1 , when its frequency was ν_1 , and has adventured into intergalactic space. In due course it may encounter one of the receding galaxies and be scattered or reflected. I consider only the case of direct reflexion back to ourselves. Let this photon be reflected after traversing a fraction f of the radius of the universe measured at the instant of reflexion, that is, let it be reflected at epoch t_2 when the radius of the universe is ct_2 and the distance of the reflecting galaxy ft_2 . Then, since the speed of the photon is c , we have

$$t_2 = t_1 + ft_2/c = t_1 + ft_2,$$

$$t_2 = t_1/(1-f),$$

or

and the photon arrives back at our own galaxy at epoch t_3 , where

$$t_3 = t_2 + ft_2 = t_1 \frac{1+f}{1-f}$$

It is then either reflected outwards again or propagated through our galaxy unimpeded. In either case it suffers no change of frequency at our own galaxy, but moves out again into intergalactic space, there to be eventually reflected back to us, and so on. After n such external reflexions back to us, it reaches us at epoch t_{2n+1} , given by

$$t_{2n+1} = t_1 \left(\frac{1+f}{1-f} \right)^n,$$

for, as is easily shown, the fraction f measuring the mean free path will be the same at all epochs.

At the first external reflexion, the frequency ν_1 is reduced by the square of the usual Doppler factor

$$\left(\frac{1-v/c}{1+v/c} \right)^{1/2},$$

once because of its absorption by the receding galaxy and once because of its re-emission by the same galaxy. Here v , the recession velocity, is by the velocity distance law $ft_2/t_2 = fc$. Hence the frequency is reduced to

$$\nu_1 \left(\frac{1-f}{1+f} \right)$$

After n such external reflexions, its frequency is reduced to

$$\nu_1 \left(\frac{1-f}{1+f} \right)^n$$

If now we call ν_0 its present frequency, t_0 our present epoch, we can write these results in the form

$$\nu_0 = \nu_1 \left(\frac{1-f}{1+f} \right)^n, \quad t_0 = t_1 \left(\frac{1+f}{1-f} \right)^n$$

Hence $\nu_0/\nu_1 = t_1/t_0$ or $\lambda_0/\lambda_1 = t_0/t_1$

Thus the wave-length of the photon is proportional to the epoch at which it is observed, independent of the value of its mean free path.

If we now pursue the history of the photon backwards in time, we see that as $t_1 \rightarrow 0$, $\nu_1 \rightarrow \infty$. Thus at the epoch of 'creation', $t = 0$, there is a singularity in photon-frequency. This is an inevitable converse of the phenomenon of the ageing of light with time. The result is in accordance with the views, put forward on other grounds, recently reached by Prof J. B. S. Haldane¹.

This result is compatible with the reception by ourselves of all frequencies at the present epoch, including the very high frequencies of the undulatory components of cosmic rays. It is thus possible that high-frequency cosmic rays are relics of the primitive high-frequency radiation.

E. A. MILNE.

Wadham College,
Oxford. Feb 6

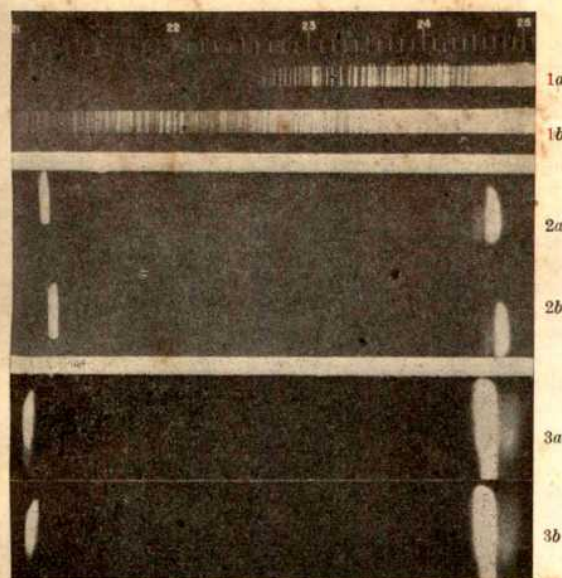
¹ *Nature*, 155, 133 (1945)

Dynamic X-Ray Reflexions in Diamond

As was first shown by Raman and Nilakantan^{1,2,3}, the (111) crystal planes in diamond exhibit sharply defined reflexions of monochromatic X-rays incident on them which are distinct from the well-known Laue and Bragg effects. The same authors³ showed that the positions of these reflexions are in perfect accord with the Raman-Nath formula derived on the basis that they arise from the quantum mechanically excited infra-red vibrations of the crystal lattice.

It has been claimed by Dr Kathleen Lonsdale⁴ that the reflexions the positions of which are given by the Raman-Nath formula are not exhibited by the kind of diamonds which are transparent to the ultra-violet up to 2250 Å. To check this claim we have carried out a series of studies with a number of cleavage plates of diamond of this variety, with the result that Mrs Lonsdale's findings are not confirmed. Our experiments were made with half a dozen different specimens, and we find no difficulty in recording the reflexions sought for with every one of them by giving adequate exposures. The real test whether the recorded effects are those being looked for is the dependence of their intensity on temperature. A thorough examination of this was carried out with one of our specimens (N.C. 125) over a wide range of temperatures, namely, from liquid air temperature upwards to 600°C, and over a variety of settings of the crystal. Microphotometric investigations showed no noticeable change of intensity as between 30°C and -187°C, while there is approximately a 5 per cent increase in going up to 300°C, and about 15 per cent in going up to 600°C. These changes are in accord with the theoretical formula given by Sir C. V. Raman, if we assume that the frequency change involved in the dynamic reflexion is that of the fundamental vibration of the lattice, 1332 cm⁻¹ in spectroscopic units. These results are illustrated by the accompanying photographs.

The appearance of sharply defined and intense X-ray reflexions of the dynamic kind can only be expected if the vibrations of the lattice have coherent phase relationship over a great many crystal spacings, and this in its turn evidently requires a high degree of crystal perfection. The investigations on diamond by Sir C. V. Raman and others at Bangalore have



1a: ABSORPTION SPECTRUM OF DIAMOND (N.C. 125).

1b: SPECTRUM OF THE IRON ARC.

2a and 2b: PHOTOGRAPHS OF THE LAUE AND DYNAMIC (111) X-RAY REFLEXIONS WITH THE DIAMOND AT 600° C. AND AT ROOM TEMPERATURE RESPECTIVELY.

3a AND 3b: SIMILAR PHOTOGRAPHS TAKEN WITH THE DIAMOND AT ROOM TEMPERATURE AND AT LIQUID AIR TEMPERATURE RESPECTIVELY.

shown conclusively that the diamonds, which are throughout of the ultra-violet opaque type^{5,6}, possess a high degree of crystal perfection. On the other hand, diamonds of the ultra-violet transparent type have a variable crystal spacing⁷, accompanied by a pronounced lamellar birefringence. It is not surprising, therefore, that the dynamic X-ray reflexions given by this type of diamond do not exhibit the same sharpness and intensity as those given by diamonds of the ultra-violet opaque kind. Indeed, even the Laue reflexions given by these diamonds often show obvious irregularities. The fact that only the most intense of the three quantum reflexions indicated by the Raman-Nath formula is observed with diamonds of the ultra-violet transparent type is also readily intelligible when the above considerations are taken into account. We have further verified that, within the limits of the error set by the imperfection of the observed reflexions, their positions agree with those given by the Raman-Nath formula.

The objections which Mrs. Lonsdale has raised against the interpretation of the X-ray reflexions observed with diamond given by the Bangalore workers are thus believed to be without experimental foundation.

R. S. KRISHNAN.
G. N. RAMACHANDRAN.

Physics Department,
Indian Institute of Science,
Bangalore.
Jan. 5.

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Thermomechanical Effect in Liquid Helium II

THE peculiar properties of liquid helium II have been the subject of many experimental and theoretical investigations during recent years. The characteristic features of liquid helium II are its superfluidity (viscosity less than one billionth of that of water) and the thermomechanical effect. The superfluidity has been explained by F. London¹ and L. Tisza² by assuming helium II to be in a state of Bose-Einstein degeneracy, a part of the atoms constituting the condensed phase. In a previous communication³, I have given a theory of the surface-flow of liquid helium II in the form of thin mobile films, and my purpose now is to discuss the thermomechanical effect in helium II assuming the latter to be in the state of Bose-Einstein degeneracy.

Landau⁴ has given a different theory based on the model of a 'quantum liquid'. H. London⁵ has given a thermodynamical discussion of the thermomechanical effect and has shown (taking the London-Tisza model of helium II) that

$$(dp/dt)_{\max.} < J\rho\varphi,$$

where φ is the entropy in cal. per gm., J is the mechanical equivalent of heat and $(dp/dt)_{\max.}$ is an upper limit to the reaction pressure per degree. The expression for the thermomechanical effect can also be obtained as follows:

The pressure and energy per unit volume in a Bose-Einstein degenerate gas are connected by the relation

$$p = C\Gamma(S)\zeta(S+1)(kT)^{S+1} = \frac{E}{SV} \quad (1)$$

S is defined by the equation

$$N(\varepsilon)d\varepsilon = \frac{VC\varepsilon^{S-1}d\varepsilon}{1/A \cdot e^{C/kT-1}} \quad (2)$$

$N(\varepsilon)d\varepsilon$ denotes the number of particles having kinetic energies between ε and $\varepsilon + d\varepsilon$.

As remarked by H. London, S is to be taken equal to 5 in order that the observed discontinuity in the (constant volume) specific heat at the λ -point may agree with the theoretical value.

From (1) we have

$$\left(\frac{dp}{dt}\right) = \frac{1}{S} \frac{d(E/V)}{dt} = \frac{\rho C_v}{S} \quad (3)$$

where C_v is the specific heat at constant volume (per unit mass). The above relation is roughly in accord with observations. For temperatures 1.393° K. and 1.241° K., C_v is equal to 0.311 and 0.174 respectively.

Thus we have for (dp/dt) at 1.393° K. and 1.24° K., the values 3.65×10^5 and 2.04×10^5 , which may be compared with the observed values 1.7×10^5 and 0.6×10^5 respectively, corresponding to the temperatures given above.

D. V. GOGATE.

Baroda College,
Baroda.
Dec. 17.

¹ London, F., *Phys. Rev.*, **54**, 947 (1938).

² Tisza, *Nature*, **141**, 913 (1938).

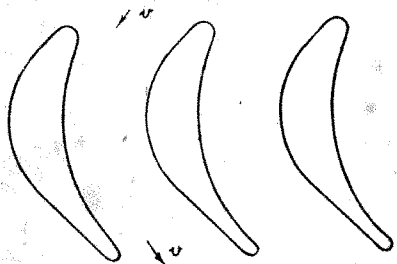
³ Gogate and Rai, *Nature*, **153**, 342 (1944).

⁴ Landau, L., *Phys. Rev.*, **60**, 356 (1941).

⁵ London, H., *Proc. Roy. Soc.*, A, **171**, 484 (1939).

'Singing' Corner Vanes

'SINGING' in wind tunnels has been observed from time to time, and we recently had the opportunity of making a study of the phenomenon in the wind tunnel of the Aeronautical Department at the University of Sydney. This tunnel is of concrete construction, has an enclosed working section, and the aerodynamic design is conventional. The corner vanes are of the constant-width annulus type and are cast in concrete with reinforcing iron rods. The cross-section and spacing are shown in the accompanying figure.



In all, seven notes were observed, and all but one of these were investigated in detail. The table lists the various notes, their origin and relevant experimental conditions. In each case, the note has a maximum intensity in the centre of the space between the cascades, where there is a strong chordwise standing wave. This standing wave is excited by either torsional or flexural vibration of the turning vanes and maintained by the alternate shedding of eddies from the trailing edges of the vanes. The phase of oscillation of alternate vanes differs by π , and the air-space oscillations are similarly related.

Note frequency (n) c.p.s.	Corner	Length of vane (l)	Air speed at corner (v)	nc/v	Elastic vibration	nl partial order	n^2/a^2
246	1st	7 ft.	37 f.p.s.	11.5	Torsional (fundamental)	1720	—
298	1st	7	45	11.4	Flexural (fundamental)	—	651
257	2nd	8	38	11.7	"	—	734
420	1st	7	64	11.4	Torsional (2nd partial)	1470	—
251	3rd	12	38	11.4	"	1510	—
249	4th	14	33	13.2	"	1740	—
280	3rd ?	12	44	11.0	Flexural (2nd partial)	—	655

*a = 22.4, 1st partial; = 61.6, 2nd partial.

That all vibrations are excited by eddies is confirmed by the constancy of the quantity nc/v , where c is the chord. The determination of the type of elastic vibration (see column 6) is made on the basis of the rough agreement with the theoretical variation of frequency with length and harmonic order, as exhibited in column 7 for torsional, and in column 8 for flexural vibrations. From the observed pattern of the sound field of the sixth note, it is certain that in this case the vanes are vibrating with a central node.

It is considered that the oscillations are due to energy transfer in the cycle: mechanical oscillation $\rightarrow$ air space standing wave $\rightarrow$ regular shedding of large eddies $\rightarrow$ forces to maintain mechanical oscillation. This cycle is made possible by the closeness of the natural frequencies of the air column between the vanes to the natural frequencies of vibration of the vanes. The comparative rarity

of this phenomenon is attributed to the high damping and natural frequency of the types of vanes more usually employed. Heavy concrete vanes with ends set into concrete walls have very low damping and comparatively low natural frequencies, and calculations of natural frequencies agree roughly with the observed frequencies. In short, the occurrence of the tones is due to a fortuitous approximate equality of the resonant frequencies of the chordwise air spaces between the corner vanes, and the natural frequencies of these vanes. In this connexion, it is to be noted that speeds in the range 35–44 f.p.s. are critical for exciting the air resonance, for these and any geometrically similar corner vanes.

G. K. BATCHELOR.

A. A. TOWNSEND.

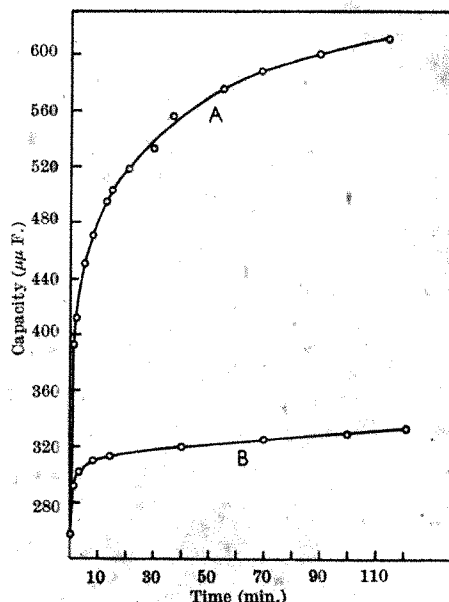
Division of Aeronautics,
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Dec. 19.

Thixotropy and Dielectric Constant of Printing Inks

INVESTIGATING the electric properties of printing inks, it was observed that the dielectric constant of an ink depends on the time it stands undisturbed in the measuring condenser. For dielectric constant determinations a commercial Philips measuring bridge, a Philscope, was used at frequencies 50 Hz and 1,000 Hz. The polarization capacity and the polarization resistance could not be measured.

The condenser was of ordinary cup-form, the diameter being 80 mm. for the cup and 70 mm for the lid. Two condensers were used—one of iron and another of aluminium, with air capacity of 33 and 41 μF respectively. No influence of the material of the condenser on the dielectric constant of printing ink was observed.

After filling the space between electrodes with printing ink and moving the lid it was possible to bring the capacity to definite and reproducible values. The capacity increased on ceasing the movement. The time-capacity curve following the first disturb



nce lies highest, higher than those for the second and following disturbances. But if after several disturbances the ink in the condenser is left to stand overnight, the previous day's disturbance-time-apacity curves can be reproduced.

Two curves for a frequency 1,000 H are represented in the accompanying figure. The ink corresponding to curve A contained 14.2 per cent I-G carbon LT and had as a vehicle a varnish with a viscosity of 62 cp. at 25° C. The ink corresponding to curve B contained 12.4 per cent of the same carbon, the viscosity of the varnish being 886 cp. at 25° C. Ink A was much more thixotropic than ink B; its viscosity yield-value was 1.75 times the yield-value of ink B in a Couette type viscosimeter. Viscosity measurements with a viscosimeter of the type described by C. F. Goodeve¹ in combination with simultaneous dielectric constant measurements on a precision bridge would enable thixotropic properties to be related to the dielectric constant - time curve, and would make it possible to investigate the phenomenon more thoroughly. I am unable at present, however, to undertake such an investigation for lack of apparatus and funds.

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Dec. 9.

A. PARTS.

J. Sci. Instr., **16**, 19 (1939).

Molecular Weight of Palmer's β -Lactoglobulin

PEDERSEN¹ made a thorough study, in the electrophoresis apparatus and the ultracentrifuge, of lactoglobulin (Palmer²). He found that it was a homogeneous protein of molecular weight 38,000 by sedimentation equilibrium and 41,500 by diffusion measurements³. Neurath and Cooper, from diffusion and viscosity measurements, quote values of 43,300 and 33,700, depending on the molecular shape. From the X-ray point of view, the limitation in the accuracy of determination of the molecular weight is the estimation of the water content of the air-dried crystal. McMeekin and Warner⁴ derived a figure of 35,800 from their measurements of the mean water content and the crystallographic data of Crowfoot and Riley⁵. However, if their lowest value for the water content is used, the molecular weight is increased to 37,200. As the osmotic pressure of β -lactoglobulin solutions is not hitherto been recorded, I have now made some measurements of it.

The sample of protein, kindly supplied by Dr. A. Svedberg, had been prepared and recrystallized three times by the method of Palmer². It was found to be homogeneous in the Tiselius electrophoresis apparatus. For the osmotic pressure measurements the following buffer (pH 5.4) was used as solvent: 0.2 M NaCl; 0.01 M Na_2HPO_4 ; 0.019 M KH_2PO_4 . The amount of protein in solution was calculated from the nitrogen content, using the micro-Kjeldahl procedure and nitrogen figures of Chibnall *et al.*⁶

The osmotic pressure measurements and calculations were carried out as described in a previous paper⁷. The accompanying table shows the osmotic pressure at 0°, the concentration in grams of dry protein per 100 c.c. of solvent and the molecular weight for a series of experiments. From these data the calculated mean molecular weight is 38,000, with

Concentration of dry protein (gm. per 100 c.c. solvent)	Osmotic pressure (mm. mercury)	Mol. weight
1.01	4.41	39000
1.085	4.78	38600
1.21	5.297	38950
1.26	5.74	37400
1.732	7.753	38050
2.485	10.91	38900
2.963	13.61	37100
2.963	13.46	37550
4.72	20.73	38800
6.50	30.30	36500

a standard error of 900 and a mean deviation of 700, which is in good agreement with Pedersen's value obtained from sedimentation equilibrium experiments.

HERBERT GUTFREUND.

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Jan. 4.

¹ Pedersen, *Biochem. J.*, **30**, 961 (1936).

² Palmer, *J. Biol. Chem.*, **104**, 359 (1934).

³ Svedberg and Pedersen, "The Ultracentrifuge" (Oxford Univ. Press, 1940).

⁴ McMeekin and Warner, *J. Amer. Chem. Soc.*, **64**, 2393 (1942).

⁵ Crowfoot and Riley, *Nature*, **141**, 521 (1938).

⁶ Chibnall, Rees and Williams, *Biochem. J.*, **37**, 354 (1943).

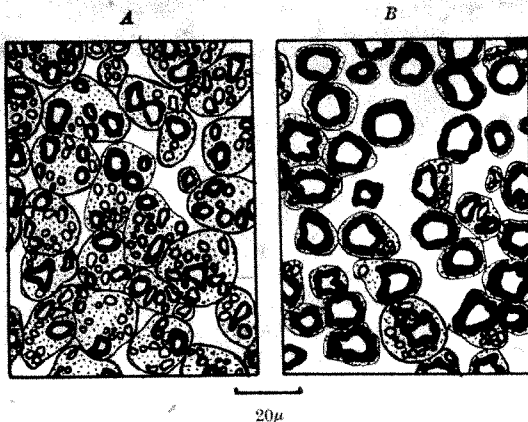
⁷ Gutfreund, *Nature*, **153**, 406 (1944).

Effect of Peripheral Connexion on the Diameter of Nerve Fibres

In recent accounts^{1,2,3} of the factors which control the size reached by regenerating nerve fibres, the hypothesis has been put forward that the Schwann tubes which replace degenerating nerve fibres in the peripheral stump control the pattern of fibre sizes by the restriction which they impose on increase of diameter. In the absence of such restriction, the diameter which a regenerating fibre attains depends upon the calibre of its parent fibre in the central stump.

As a result of further experiments, it has now become clear that a third factor, namely, the re-establishment of connexion with a muscle or sensory ending, also has a profound influence on the size attained by regenerating fibres. In these new experiments both peroneal nerves of the rabbit were interrupted by crushing high in the thigh. The nerves were also cut at the knee, and on one side the cut stumps were immediately rejoined, so that functional regeneration occurred. On the other side, the lower end of the nerve was turned aside, so that the fibres formed a neuroma, having no connexion with the periphery. The animals were killed 100 or 200 days later. In the nerves which had not been allowed to make connexion with the periphery a large number of small medullated fibres was found, usually several in each of the Schwann tubes left by degeneration. The nerves which had been allowed to make normal terminal connexions contained fewer and larger fibres. Weiss and Taylor⁴ have observed a similar effect; of the two parts into which a regenerating nerve was divided, that which was allowed to become reconnected with the periphery acquired larger fibres.

That length of nerve is not a factor which controls maturation was shown by a second set of experiments. In these the length of nerve to be regenerated was made short on one side of the animal, long on the other. This was done by crushing



SCHWANN TUBES AND FIBRES IN THE PERIPHERY OF CRUSHED NERVES 200 DAYS AFTER OPERATION: (A) WHERE THE FIBRES HAVE BEEN PREVENTED FROM MAKING ANY PERIPHERAL CONNEXION; (B) WHERE THE FIBRES HAVE BEEN ALLOWED TO INNERVATE A MUSCLE. THE DRAWINGS ARE OF COMPARABLE FIELDS TRACED FROM PHOTOGRAPHS OF WEIGERT PREPARATIONS.

both peroneal nerves at the same level, and lower down, cutting and joining them to the tibial in such a way that on one side the fibres were made to grow to twice their normal length. In spite of the different lengths regenerated, the fibres at a standard level below the crushed points on the two sides were found to be of similar diameter when examined 100 or 200 days after operation.

Evidently, therefore, it was the connexion with an end organ which influenced the size attained by the nerve fibres in the first experiment. When a nerve is crushed, many new fibres grow out down each of the tubes in the peripheral stump. Presumably, if one of these connects with an end organ, it hypertrophies at the expense of the others in the same tube. If no peripheral connexion is made, many begin to medullate, but none becomes large.

Such an influence of the end-organ on the nerve is probably of great importance in development as well as in regeneration, in ensuring that the nerve fibres shall come to have appropriate diameters. But the exact way in which the influence is exercised remains to be discovered; we do not know whether it depends merely upon connexion of the fibres with an end-organ, or upon the actual resumption of function by the system.

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J. Z. YOUNG.

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- ¹ Gutmann, E., and Sanders, F. K., *J. Physiol.*, **101**, 4, 489 (1943).
² Sanders, F. K., and Young, J. Z., *J. Physiol.*, **103**, 1, 119 (1944).
³ Simpson, S. A., and Young, J. Z., *J. Anat. (Lond.)* (in the press).
⁴ Weiss, P., and Taylor, A. C., *J. exp. Zool.*, **95**, 2, 233 (1944).

Effects of Constant Current in Relation to 'Functional Polarity'

WHEREAS the effect of constant currents on the peripheral nerve has been thoroughly investigated, very little work has been done on the effects of such currents on the central nervous system. However, during the last few years, a number of papers has been published by Scheminzky and his co-workers. They found that the effect of passing a constant current through a frog depended on the direction of the current. While a descending current (that is, in the head-to-foot direction) produced paralysis (gal-

vano-narcosis), an ascending current produced convulsions. Scheminzky thought that it was impossible to explain this phenomenon in any other way than by a 'functional polarity', involving an assumption that the whole of the central nervous system is built up of a series of polarized elements, succeeding each other along the axis of the system. He claims to have discovered "a new law of the general physiology of the central nervous system"—a law which would be rather difficult to understand.

To elucidate this problem, we at first investigated the effect of constant currents on a single centre, namely, the respiratory centre of the frog. If one electrode is put on the bulb, and the other at some point lower down on the spinal cord, a reduction of the depth and frequency of respiration is generally produced when a current of several tenths of a milliamperé is passed in descending direction. An ascending current produces just the opposite effect. This evidently resembles Scheminzky's experimental results. But it is easy to demonstrate that the observed effect has nothing to do with the direction of the current; on the contrary, it depends exclusively upon the electrical charge applied to the respiratory centre. The excitatory effect of the cathode and the depressive effect of the anode on the centre remain unchanged if the second electrode is removed from the spinal cord and put on the brain, so that the direction of the current is reversed. The effect also remains the same if the second electrode is put somewhere outside the central nervous system, for example, on the fore leg.

This fact having been firmly established, Scheminzky's observation was followed up with the same point of view in mind. We found that if one electrode is put on the spinal cord and the second electrode outside the central nervous system, the cathode on the spinal cord produced convulsions while the anode did not. A reversal of the Scheminzky phenomenon was not so easy to produce as in the respiratory centre, but finally we found a way to demonstrate here too. The effect of the current does not, of course, depend upon the place where the electrode (the end of the physical conductor) is applied; it depends on the place where the current enters or leaves the tissue to be affected, the physiological electrode. If, for example, one electrode is put on the head of the animal and the other near the cloaca, the effect on the lower extremities is usually unchanged after cutting the spinal cord, because cutting does not mean anything other than moving the physiological electrode from the brain to the place of section of the spinal cord. Now, after extirpation of a small segment of the spinal cord, if one electrode is placed, as before, on the head, and the second electrode is put on the caudal surface of the lower part of the spinal cord, a perfect reversal of the Scheminzky phenomenon can be obtained: with a descending current (cathode on the spinal cord), convulsion was produced, which did not occur with an ascending current (anode on the spinal cord).

In this way Scheminzky's observation is reduced to the well-known catelectrotonic increase and an electrotonic decrease of nervous excitability, and the stimulating effect of the cathode and the paralytic effect of the anode. The only question to be resolved was why a current passing in one direction (descending) should produce the anodic effect, and in the opposite direction (ascending) the cathodic effect. This behaviour may be explained by another well-known fact, namely, the dependence of the lower

spinal centres upon the higher ones. We know that after elimination by cutting or simply by cooling of the higher (that is to say, upper) centres, for some time at least, the lower centres may be paralysed. So, if the brain and upper centres are nearer to the anode (descending current), their anelectrotonic elimination has a paralysing effect, while their catelectrotonic excitation with an ascending current produced convulsions.

The explanation of Schemmizky's observations, therefore, needs no 'functional polarity', the existence of which is directly contradicted and refuted by the reversal demonstrated in our experiments.

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Changes in the Red Blood Cells in Chronic Infections

THE anæmias of chronic infection have not been elucidated in spite of the frequency of their occurrence. An investigation was undertaken to study the changes in the red cells in these conditions.

The following results were obtained. The red cell count is usually reduced to only a small extent. The hæmoglobin reduction is relatively greater.

In a few cases a high colour index anæmia exists. In most the colour index is either normal or reduced. Analysis of the detailed characters of the red cells shows that there is a marked tendency to increase in the erythrocyte volume and diameter. The thickness of the cells, on the other hand, tends to remain within normal limits, the cells therefore being flat. Associated with this the red cells are resistant to hypotonic saline hæmolysis, and target cells are seen in blood smears in increased numbers.

The individual red cell has been shown to be hypochromic.

The absence of features suggesting excessive hæmolysis of the red cells is confirmed.

The bone marrow function appears to be reduced in respect of erythropoietic function.

The anæmia of chronic infection is therefore dimorphic, that is, there is evidence of two factors at work, one causing hypochromia and another causing increase in the volume and diameter of the cells. The macrocytosis can be related to the defective liver function demonstrated in these cases. The hypochromia is due to defective utilization of iron by the depressed bone marrow.

The level of the anæmia shows a remarkable tendency to be fixed in chronic infections. This has been attributed to the setting of the bone marrow at a new low level by the products of inflammation absorbed from the infected area.

By analogy with cases of non-hæmolytic jaundice studied at the same time, it is suggested that some of the features of the red cells in the anæmias of chronic infections are due to disturbance of the normal effect of the spleen on circulating red blood cells. The anæmia of chronic infection, therefore, may be interpreted as a toxic dimorphic dyshæmopoietic anæmia with hypoplenism.

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Dec. 7.

A Crystalline Serum Muco-Protein with High Choline-Esterase Activity

IN a recent communication under the above title, we mentioned that "it appears to be an undecided question whether choline-esterases from different tissues, such as blood and brain, are identical".¹ This cautious statement has caused Mendel, Rudney and Strelitz to say² that "it has definitely been established that choline-esterases from different tissues are not identical", and that they have "conclusively demonstrated" the existence of two distinct choline-esterases.

While we were aware of the work of Mendel, Rudney and Strelitz, and agree that their claims may well be correct, we felt that in the present state of knowledge of this enzyme (enzymes) it seems premature to speak of them as having been "definitely established". We might recall that no electrophoretic or closer elementary analysis has yet been reported. Moreover, kinetic studies like, for example, those of Northrop on pepsin, and a study on an eventual shift of the pH-optimum in presence of different ions, appear to be necessary before such definite conclusions can be drawn. Recollections of the analysis of well-known problems like the high rennin activity of crystalline pepsin, linked with elementary analysis of both rennin and pepsin preparations; the diaphorase activity of xanthine oxidase, the identity of xanthine oxidase with aldehyde oxidase, etc., make us hesitate to claim so much as Mendel *et al*.

Mendel, Rudney and Strelitz raise another point in their communication which, however, has little of no connexion with the question of the identity of the choline-esterases of brain and serum. They reported earlier the isolation of an extremely active preparation (non-crystalline) of serum choline-esterase, while we reported a less active preparation (crystalline) from the same source. Although, as can be seen from our title, we never claimed to have obtained crystalline serum choline-esterase, they argue that in comparison with their product our preparation is grossly impure. Here again we are inclined to see things more from the point of view of the many established facts which are known from enzyme studies. Crystalline enzymes, even those regarded as pure, are often less active than non-crystalline preparations (for example, Sumner's crystalline catalase and Agner's preparation), for loss of activity is often due to a more efficient removal of certain essential activators. The classical work of Sumner *et al* showed how the presence of different ions (acetate, citrate and phosphate), as well as different substrate concentrations, were capable of shifting the pH-optimum of crystalline urease considerably, so that one and the same enzyme preparation, under slightly different conditions, but at the same pH and substrate concentration, showed a difference of activity as great as 70 per cent or more. At pH 7.5, for example, crystalline urease is at its optimal activity using phosphate buffers, whereas with acetate buffers its activity is down to approximately 15 per cent.

It seems premature, as Mendel *et al* have attempted, to calculate how much "inert material" our crystalline preparation contains. All the more, because none of the essential characteristics of the preparations of Mendel *et al* or ourselves (for example, pH-optimum influence of different ions, etc.) was available to make a calculation of this sort possible. These characteristics, as shown by the example of crystalline urease,

can account for very great discrepancies in activity. Incidentally, we are at a loss to see any 'controversy' (a term used by Mendel *et al.*), at best there is a discrepancy, the clearing up of which will have to await the determination of the aforementioned essential characteristics

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¹ Bader, R., Schutz, F., and Stacey, M., *Nature*, 154, 183 (1944)

² Mendel, B., Rudney, H., and Streitz, F., *Nature*, 154, 737 (1944).

Acceleration of Reproduction in Terrestrial Isopoda

MR A. E. NEEDHAM, in one of his valuable contributions to the micro-anatomy of the Isopoda, remarks¹, "Stimulation of an ovigerous female in the region of the anterior opening of the brood pouch causes premature release of the brood and is elicited with increasing facility as incubation approaches full term"

I was greatly interested in this statement as I have accelerated reproduction in *Armadillidium vulgare* (Latr.) and several other species² by keeping them in a temperature slightly higher than that prevailing out of doors. Dr H. W. Howard has obtained similar results³.

The duration of the embryonic and larval periods seems, according to different observers, to differ greatly. Pierce⁴ writes, "The period of incubation in this species [*Armadillidium vulgare* (Latr.)] is long, between fifty-six and ninety-three days, according to the varying results obtained. As no individuals were secured in copula, the exact time of its duration was not recorded. The development of the eggs may be watched from the exterior. The females should be treated very carefully."

Dr H. W. Howard, who has had exceptional experience in the breeding of this species in connexion with his valuable work on its genetics, sends me (*in litt.*, Nov 29, 1944) a long series of records which show the minimum period of incubation to be 39 days, the next lowest is 44 days, and the maximum 78 days, the average of the whole series being about 57 days.

Heeley⁵ states, "In *A. vulgare* the embryonic development is short, whilst the larval development is relatively long." He gives the average of the embryonic period as 33 days and that of the larval period as 8 days, both of which surprise me, differing as they do so strikingly from the figures obtained by Pierce, Howard and myself.

Under normal conditions (indoors) the shortest periods I have obtained are 44 + 10 days. Howard's lowest records are 39 days and 44 days.

The figures for twenty-four broods I have bred are as follows

Number of broods	Average embryonic period (days)	Average larval period (days)	Total incubation period (days)
One	44	10	54
Four	46	12	58
One	48	12	60
Two	46	12	58
Four	48	12	60
Six	49	12	61
Three	52	10	62
Three	58	10	68

These figures refer to the shortest periods, others have exceeded by 10 to 16 days.

The idea of stimulation was quite new to me, I therefore made the following experiments. Some specimens of *Armadillidium vulgare* var. *rufobrunneus* Cllge were observed on October 1 to have formed brood pouches and on October 8 tiny eggs could be seen within. Taking a specimen between my finger and thumb on October 10, I very gently stroked the brood pouch with a very fine, small camel-hair brush. This was repeated on October 13, 15, 18 and 22. The egg membranes were burst on November 8, making a total number of 31 days for the embryonic period. The larval period occupied 8 days, making a total of 39 days for the incubation period. In a control experiment the embryonic period was 30 days and the larval period 8 days.

Only once have I obtained a brood in 54 days, the average of a long series being 64 days.

An examination of many of the newly liberated specimens showed them to be normal in every way and of the average size.

There was a very noticeable change in the size and appearance of the eggs after the third stimulation in both series.

Under normal conditions, my experience is that the embryos of this species develop very slowly during the first fourteen or fifteen days. The most rapid changes are those made during the last fourteen days before the young leave the eggs.

To what extent stimulation might be applied in other groups of animals, without any deterioration of the young, is a subject well worthy of further investigation.

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¹ *Quart. J. Micro. Sci.*, 84, 59 (1942)

² *N.W. Nat.*, in the press

³ *N.W. Nat.*, in the press.

⁴ U.S. Dept. Agric., Bur. Entom., No. 64, Part 2 (1907)

⁵ *Proc. Zool. Soc. Lond.*, B, III, 98 (1941)

Survival of *Fasciola hepatica* L. in vitro

No systematic attempts at culturing this liver fluke *in vitro* have yet been made. The survival times in published accounts are very short, and physiological work on such short-lived organisms is highly suspect. Ordinary Ringer solutions were used, and the flukes lived from 5 to 12 hr.^{1,2,3,4}

In the present work, which is preliminary to the study of the respiratory metabolism, a series of saline solutions were used, and the following results obtained: (1) Borates prolong survival, presumably by control of bacteria. Other controlling agents are either toxic to the worm (acriflavine, merthiolate, silver protein) or have no effect on survival times (sulphanilamide). (2) The optimum pH is 8.1–8.5, the optimum temperature 36°C. (3) Wide variations in osmotic pressure, K/Na ratio, and Ca/Na ratio have little effect on survival. (4) The presence of bile salt or peptone has virtually no effect. This is probably because of an increased bacterial flora, which borates and sulphanilamide are incapable of controlling. (5) Sugars increase survival times in the following order: fructose > glucose > galactose = maltose > lactose = sucrose. Disaccharides are thus less effective than monosaccharides, and are evidently not broken down to monosaccharides by enzyme action. Probably they are not reaching the worm's gut. (6) Ligatured worms in glucose survive essentially as long as unligatured controls. This suggests that glucose can enter through the body wall.

Flukes can be kept alive for 60 hours at 36° C in the following solution NaCl 150 mM, KCl 10 mM, CaCl_2 1 mM, borax 6 mM., glucose 30 mM, pH 8.6. Survival times can be further increased by using lactose instead of glucose, and by the addition of 5,000 trypan blue⁵, but the medium as stated is simpler and cheaper, and thus more suitable for large-scale work. A survival time of 60 hours, although disappointing, is a considerable advance upon previous records, and is adequate for preliminary tests of the effects of anthelmintics *in vitro*. Certain of these tests have been carried out, and it has been shown that carbon tetrachloride, probably the most effective anthelmintic *in vivo*, is innocuous *in vitro*.

WILLIAM STEPHENSON

Department of Zoology,
University of Bristol Jan 13

Ullner, *Zool Anz*, 57, 273 (1923)

Reinland and von Brand, *Z. vergl. Physiol.*, 4, 212 (1926)

Ullner and Léeb, *Klin. Woch.*, 5, 2054 (1926)

Ullner, *Z. vergl. Physiol.*, 17, 365 (1932)

Ullner, *Chin. Med. J.*, 54, 409 (1938)

Control of Red Spider Mites

SINCE the discovery in 1936 of its insecticidal properties, 2,4-dinitro-6-cyclohexylphenol¹ has been widely used in the United States for the control of tetranychid mites. Successful control has been obtained of *Paratetranychus citri* (McG.)^{2,3} and of *Tetranychus telarius* (L.) on citrus, cotton⁴ and hops⁵, and all these crops damaged by red spider is of considerable economic importance, and this substance is the only synthetic compound which has been successfully applied to control on a large scale. It is of interest that 4,4'-dichloro-diphenyl- $\beta\beta\beta$ -trichloroethane (DDT) is of no use as an acaricide. Later work has established that the phytocidal effect of 2,4-dinitro-ortho-cyclohexylphenol can be diminished by the addition of its dicyclohexylamine salt without impairing its properties as an insecticide or acaricide. Experiments recently carried out in the field from a laboratory have established that control of *T. telarius* can be obtained on hops and on greenhouse tomatoes in Great Britain.

The experiments on hops were carried out in Kent in September. Two proprietary dusts and one dust of kaolin as filler were used, all three dusts contained 1 per cent of 2,4-dinitro-6-cyclohexylphenol, the dicyclohexylamine salt, and $\frac{1}{2}$ lb was applied to each plant. Both were also applied as aqueous suspensions, and the compatibilities with cuprous chloride and copper oxychloride, and of the salt with lime were tested.

Treatment	Mites counted	% killed
Proprietary dust A	2100	94.8
Proprietary dust B	1630	94.3
Dicyclohexylamine salt cont.	1600	82.3
2,4-dinitro-6-cyclohexylphenol	1780	26.6
2,4-dinitro-6-cyclohexylphenol with kaolin		
ers of sulphur		
Aqueous Suspensions		
% dinitro-cyclohexylphenol	2920	98.4
5% "	4500	97.0
5% "	1100	96.6
5% "	685	97.2
5% dinitro-cyclohexylphenol + 0.5% proprietary cuprous oxide	1600	91.1
5% " + 0.5% copper oxychloride	1950	95.2
5% dicyclohexylamine salt with dinitro-cyclohexylphenol	1140	97.9
5% " + 0.037% nicotine	780	93.3
Lime sulphur	2130	65.5
Control untreated	1605	9.8

0.025 per cent of the salt as a suspension gave a 96 per cent kill against 65 per cent with a standard lime sulphur used widely by the growers. With the dusts, a 94-95 per cent kill was obtained against 27 per cent with flowers of sulphur.

The mortality was only slightly reduced by the addition of cuprous oxide, copper oxychloride and nicotine.

It was further found that 60-70 per cent of the eggs were killed by application of 0.025 per cent suspensions of the dinitro compound and of its mixture with the dicyclohexylamine salt.

Experiments to compare the use of dinitro-cyclohexylphenol and of its mixture with the dicyclohexylamine salt and the ammonium salt of 2,4-dinitro-ortho-cresol in killing *T. telarius* on greenhouse tomatoes in October, showed up markedly the superior properties of the dicyclohexylamine salt under conditions where plants are liable to be easily damaged. It was found that on tomatoes, satisfactory cover of the foliage could not be obtained without the addition of a wetting agent.

Treatment	Mites counted	% kill	Damage to plants
0.03% dinitro-cyclohexylphenyl	109	77.1	Very slight
0.006% "	194	87.6	Slight
0.012% "	795	88.0	Some severe damage
0.025% "	—	—	Plants killed
0.006% " with the dicyclohexylamine salt	561	66.3	Slight
0.012% " " "	725	90.1	Slight
0.025% " " "	524	91.0	Slight
0.018% dinitro-ortho-cresol	—	—	Plants killed
0.036% " " "	—	20	Plants killed

Ammonium dinitro-ortho-cresylate killed the plants completely at dosages too small to be lethal to the red spider mite. 0.025 per cent of dinitro-cyclohexylphenol as the salt gave a 91 per cent kill and caused insignificant damage, while the same concentration of the free phenol killed the plants.

Preliminary experiments with *Oligonychus ulmi* Koch on damsons have given similar promising results.

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Pest Control, Ltd.,
Harston, Cambridge Dec 12.

¹Kagy, T. B., and Richardson, C. H., *J. Econ. Ent.*, 29, (1), 52 (1936)

²Boyce, A. M., et al., *J. Econ. Ent.*, 32, 432 (1939)

³Kagy, J. F., and McCall, G. L., *J. Econ. Ent.*, 34, 119 (1941)

⁴Isely, D., *J. Econ. Ent.*, 34, 323 (1941)

⁵Morrison, H. E., and Mote, D. C., *J. Econ. Ent.*, 33, 614 (1940)

Control of White Rot in Onions

WHITE rot in onions and other *Allium* species has been recorded in many countries and has increased in severity in England during recent years. The disease is caused by the fungus *Sclerotium cepivorum* Berk., which survives for several years as sclerotia in the soil, and is therefore difficult to control by cultural methods. Ogilvie and Hickman¹ obtained satisfactory control by broadcast applications of a proprietary fungicide containing hydroxymercurychlorophenol, but this treatment did not come into general use, possibly on account of the high cost. Apart from this, no direct control method has been recommended.

In trials made during 1943 and 1944, mercurous chloride (calomel) showed promise as a means of controlling white rot in spring-sown onions, var 'James' Keeping. The best results were obtained by the

application of 4 per cent calomel dust to the seed drill at the time of sowing. The drills were opened, the dust was applied and roughly mixed with the soil. The seed was then sown and the drill closed. One pound of 4 per cent calomel dust to 50 yd of drill appeared sufficient for salad onions raised from March sowings, but 1 lb per 25 yd gave better results on bulb onions grown from seed.

Full details of these trials will be published elsewhere, and in view of the prospect of controlling this obstinate disease by an economical direct method, the work is being continued and extended in 1945.

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¹ Ogilvie, L., and Hickman, C J, *Rep. Agric Hort Res Sta Bristol for 1937*, 96 (1938).

'Bolters' in Potatoes

Carson and Howard in their recent letter¹ consider the possibility that the 'bolter' sport which occurs in many varieties of potatoes is due to chromosome abnormality—excess or deficiency. Their examination of root tips, however, forces them to conclude that there is no chromosome difference between 'bolter' and normal.

Experience has shown that critical study of small chromosomes can only be made at meiosis, using a technique which does not allow contraction². Again the possibility of chromosome loss in roots which need not occur in the germ track must not be overlooked^{3,4}.

From material supplied by Dr McIntosh, Edinburgh, and Mrs McDermott, Sutton Bonington, I have examined normal and aberrant types among the varieties Gladstone, Doon Star and Majestic. While there are no gross chromosomal changes, a small fragment was observed at meiosis in the 'bolter' types but in none of the corresponding normal or, for that matter, 'wilding' types. The accompanying illustration shows this fragment in a 'bolter' form of Gladstone. It is too small to determine whether it is euchromatic or heterochromatic.

It seems likely therefore, although not yet certain, that the mutation is due to the production of this

fragment which, of course, will be similar in its effect to the mutation of a group of genes such as Cars and Howard infer from their breeding results. I observe, of the fragment, if it is responsible, will however, facilitate the study of the mutation.

I am much indebted to Mr. S. Revell for technical assistance in this work.

P. T. THOMAS.

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Merton, S W.19

Jan 9

¹ Carson, G. P., and Howard, H. W., *Nature*, 154, 829 (1944).

² Thomas, P. T., *Stain Technology*, 15, 167 (1940).

³ Janaki-Ammal, E. K., *Nature*, 146, 839 (1940).

⁴ Darlington, C. D., and Thomas, P. T., *Proc. Roy. Soc. B*, 130, (1941).

Effect of Controls on Stability

DURING the War the introduction of government controls has led to many matters being dealt with in an order fixing some quantity, price or other variable where a *laissez-faire* system would have allowed them to find their own levels. As examples we have rates of foreign exchange, wages and prices. Not only has this fixing occurred in many instances during the War, but a further extension of control or planning in peace will probably lead to even more variables being fixed in this way.

It is the purpose of this communication to point out the danger that in any dynamic system the fixing of one variable may render the rest unstable, and it will be shown that there is one type of variable particularly likely to lead to this result. (In a social or economic system the change to an unstable state would be shown by the subsequent growth of various peculiar and undesirable 'vicious circles'.)

The theory may be shown in the following way: a dynamic system in general, of n variables, has equations of form

$$\frac{dx_i}{dt} = f_i(x_1, \dots, x_n) \quad (i = 1, \dots, n).$$

Near an equilibrium point (at which the fluxes are zero) the equations may, without serious loss of generality, be considered linear

$$\frac{dx_i}{dt} = a_{i1}x_1 + a_{i2}x_2 + \dots + a_{in}x_n \quad (i = 1, \dots, n).$$

For a system to be stable at the equilibrium point, it is necessary and sufficient that the real parts of the roots of the equation

$$\begin{vmatrix} a_{11} - \lambda & a_{12} & \dots & a_{1n} \\ a_{21} & a_{22} - \lambda & \dots & a_{2n} \\ \vdots & \vdots & \ddots & \vdots \\ a_{n1} & a_{n2} & \dots & a_{nn} - \lambda \end{vmatrix} = 0$$

are all negative. (Since we are discussing an actual system, the quantities a_{ij} will all be real.) Furthermore, since we are discussing an equilibrium point which has existed for some time under free conditions, we may suppose it stable.

Now suppose we fix x_n . The stability of the remainder will depend on the real parts of the roots of the equation

$$\begin{vmatrix} a_{11} - \lambda & a_{12} & \dots & a_{1,n-1} \\ a_{21} & a_{22} - \lambda & \dots & a_{2,n-1} \\ \vdots & \vdots & \ddots & \vdots \\ a_{n-1,1} & a_{n-1,2} & \dots & a_{n-1,n-1} - \lambda \end{vmatrix} = 0$$



PHOTOGRAPH SHOWING EXTRA FRAGMENT (SMALLEST FRAGMENT, IN CENTRE) AT MEIOSIS IN A 'BOLTER' FORM OF GLADSTONE ACETOCARMINE SQUASH THOMAS METHOD¹ × 2000

the stability of the first system by no means implies the stability of the second system. It is clear, then, that fixing a variable may render the rest of a system stable.

As a numerical illustration, the system

$$\left. \begin{aligned} \dot{x}_1 &= 6x_1 + 5x_2 - 10x_3 \\ \dot{x}_2 &= -4x_1 - 3x_2 - x_3 \\ \dot{x}_3 &= 4x_1 + 2x_2 - 6x_3 \end{aligned} \right\}$$

leads to the equation

$$-\lambda^3 + 3\lambda^2 + 26\lambda + 60 = 0,$$

which has roots -2.44 , $-0.28 \pm 4.95i$, where $i = \sqrt{-1}$. The real parts being all negative, the system is stable. But if we fix x_3 , we have a system with determinant

$$\begin{vmatrix} 6 & 5 \\ -4 & -3 \end{vmatrix},$$

and as the roots are now $+1$ and $+2$, the system is unstable.

We can, however, go further than this. Since the sum of the roots is equal to the sum of the elements of the main diagonal, Σa_{nn} , any change making this sum negative will tend to make the system less stable, other things being equal (the argument here is admittedly imprecise). So the fixing of x_n would be particularly likely to lead to instability if a_{nn} was large and negative. We can identify such variables without difficulty, for, as they behave in accordance with the equation

$$\frac{dx}{dt} = \zeta + ax,$$

where ζ is independent of x , but changes with time, while a is large and negative, such a variable (x) will always have the properties that (1) it always moves towards $-\zeta/a$, (2) it moves towards $-\zeta/a$ quickly, as $-\zeta/a$ has a as denominator it will be small, and therefore the fluctuations of x will be small.

It is concluded, therefore, that (1) To fix a biological or economic variable by order carries no danger of rendering the system, or parts of it, unstable (the latter being shown by the subsequent development of various 'vicious circles'). (2) The type variable more particularly dangerous from this point of view is one which, under free conditions, changes value at high speed, and, by these quick changes affecting the other variables, fluctuates only over a narrow range.

Not being an economist I cannot give detailed instances, but I have little doubt that some could be provided.

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Vibrations in Telegraph Wires

WALKING near Winchcomb on December 27, we noticed a most curious phenomenon. We were in a light valley, and the road was crossed by a line of telegraph wires, there being two wires some distance apart. It was about 10.30 a.m. and the sun, shining on the wires, was just beginning to thaw the layers of frost on them. The temperature of the air must have been round about freezing-point, and there was a slight mist. But we felt no breath of wind whatsoever, nor did the dead leaves of trees very near the wires indicate any wind.

But when we arrived on the scene, the wires between two of the poles were vibrating in a very odd manner. The effect was startling as there was no other noise in the neighbourhood, and there appeared to be no cause whatsoever. The wires vibrated with about 4 nodes in them, and with amplitude roughly half an inch; frequency approximately 10 a second. The vibrations went through maxima at irregular intervals, about 2 seconds apart, and we think both wires vibrated independently. The layer of frost was slowly coming off the wires, though some pieces circled round for several minutes. The cause of the vibrations seemed to be the section of the wire just being thawed, and though the vibrations were, of course, transmitted to the neighbouring sections, all the rest of the wire was quite normal. The poles on either side shook considerably, and the effect of putting one's head against them was very like that of being in a bus. But there was no earthquake, all other objects, trees or fences, being quite still. The vibrations were decreasing in amplitude about 10 minutes after our arrival, and when we returned after half an hour, they had ceased completely.

We feel sure an explanation of this phenomenon must involve the layer of frost round the wire. The only suggestion we can make is that when the layer was formed, considerable strains were set up in the wire. When it thawed, the strains were relieved suddenly in various small parts of the wire, each time giving the vibrations a small impulse. There must then be enough such impulses to maintain continuous vibrations. But this theory does not appear very plausible to us. Also we do not think electrical impulses from heavy currents could possibly account for the effect.

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Jan 2

WITH reference to the above communication, we offer the following explanation.

This is a case of self-excited vibration. It would appear that the cross-section of the wire was non-circular due to the secretion of an ice-layer. The cross-section will resemble a short icicle.

If the wire achieves a small downward velocity, and a very slight wind be blowing, aerodynamic reasoning indicates that a force in a downward direction may result. Thus the motion continues, until the elastic forces in the wire stop it. There being now no downward motion, there is no downward force, and the wire commences to rise, in which motion the wind again helps. Thus large vibrations may be set up.

The effect, commonly known as 'galloping', occurs moderately frequently in cold climates, but is rare in temperate zones.

Further information is given in "Mechanical Vibrations", by Den Hartog, p. 343, and the fiftieth James Forrest Lecture delivered by Prof. C. E. Inglis at the Institution of Civil Engineers in 1944.

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X-RAY EQUIPMENT FOR CRYSTALLOGRAPHY

ON November 25, 1944, a meeting of the X-Ray Analysis Group of the Institute of Physics was held in the Physics Department, University of Leeds. The meeting was opened by the chairman of the Group, Sir Lawrence Bragg. Sir Lawrence said that the necessary equipment and assistance had been found for scientific men to carry out emergency programmes of war-time research, and this must be extended in post-war planning. As the progress of crystallography is conditioned by the provision of equipment, it had been decided by the X-Ray Analysis Group to bring manufacturers and users together to discuss design and development, so that in the future suitable apparatus might readily be available.

The first two papers were on the development of the demountable X-ray tubes of Messrs Metropolitan-Vickers Electrical Co., Ltd., and were presented by Dr R. Witty and Mr. P. Leech. In the first paper, Dr Witty spoke about the firm's standard demountable crystallographic X-ray tube, and emphasized the two points on which differences of opinion have been found among the users of the tubes, namely, the automatic gear of the instrument and the stability of the electron emission of the filament. He agreed that early types of automatic gear caused some trouble and loss of time, but considerable improvements have been made during recent years. Filament current will be stabilized either by galvanometer or electronic relays. Mr P. Leech then spoke about the rotating anode tube with a seal of the Muller-Beck type which is being designed for post-war manufacture. A shielded filament tube is being contemplated to overcome the deposition of tungsten on the target. Ancillary spectroscopic equipment is being designed including low-angle, Weissenberg and high-temperature cameras.

Mr R. A. Stephen, of Messrs Philips Lamps, Ltd., drew up a series of specifications for a sealed-off X-ray tube. He said that multi-anode tubes cannot be manufactured at present because of mutual contamination of surfaces. Single-target tubes of copper, cobalt, iron, chromium, molybdenum and tungsten are made, but zinc and manganese targets cannot be used because of the high vapour pressure of these metals. The characteristic radiation output is given by the equation $P = K(V - V_c)^{1.65}$, where V is the applied and V_c the critical radiation voltage. This holds for kilovoltages up to four to five times the excitation voltage of the characteristic radiation. In a good vacuum the insulation is estimated as about 10–20 kV per mm. A word of warning was given about the use of unknown transformers with self-rectifying tubes, as this may put high electrical strain on the instrument due to the suppressed wave. X-ray windows are usually of 0.12 mm Lindemann glass, which is capable of standing the required mechanical strain, but it must be carefully shielded from electron bombardment. Beryllium windows are in use, and a beryllium alloy (containing up to $\frac{1}{2}$ per cent titanium) is being investigated as a window material. These metals have the advantage of not requiring to be screened. Figures of absorption of these different materials were compared. Traces of water vapour in the sealed-off tube cause the formation of tungsten oxide on the filament, and evaporation of the oxide and subsequent reformation of water vapour give a

reversible reaction which produces deposits of tungsten on the target 10,000 times greater than would be expected. It is therefore essential to use a 'getter' during the life of the tube. The design of a shielded filament was discussed. The minimum safe diameter of a crystallographic X-ray tube with a Lindemann glass window was given as 60 mm. The maximum tolerance loading per unit area of a target is given by the equation

$$T_M = \frac{2W}{\pi k} \left\{ a \log \left(\frac{b}{a} + \sqrt{1 + \frac{b^2}{a^2}} \right) + \frac{b \log \left(\frac{a}{b} + \sqrt{1 + \frac{a^2}{b^2}} \right)}{2} \right\}$$

where W is the watts per cm² on a rectangular focus $2a \times 2b$, T_M is maximum temperature permissible of the target, and k the thermal conductivity of the anode.

Mr Stephen then discussed the design of the line focus. The usual size is 12 mm $\times$ 1.2 mm and this gives an effective focal-spot size of 1.2 mm $\times$ 1.2 mm when the beam is taken off the anode at an angle of 6° to the line focus. If crystallographers were to standardize spectrometer design, then it might be possible to build a tube with a line focus 36 mm $\times$ 1.2 mm. This would give an effective spot-size of 3.6 mm $\times$ 1.2 mm, which would be admirable for use with a slit-type collimator. With a monochromator this beam could be concentrated further into an area of either 1.2 mm $\times$ 1.2 mm or 3.6 mm $\times$ 0.4 mm, depending upon the direction of reflexion of the beam from the crystal monochromator.

Dr D. P. Riley, of the Cavendish Laboratory, Cambridge, read a paper on monochromators. Slides were shown of X-ray pictures of liquids with spurious lines due to the characteristic absorption of reflexion of part of the white radiation. These false intensity peaks were shown to be absent when a beam of radiation from a monochromator is used. In designing a monochromator the crystal should be capable of rotation and also a lateral movement parallel to the axis of the tube. A crystal used as a monochromator should reflect a strong beam of sufficient breadth to bathe the sample under investigation. The crystal, which should not be mechanically deformable, should have a reflecting face of 3–5 mm² and should also have a high F value, be mosaic but not polycrystalline, and should be reasonably stable to heat, humidity and X-rays. It was said that planes with low Bragg angles are best, but the reflexion must be clear of the main beam of X-rays. Examples of monochromators were given. In using reflected radiation a beam of wave-length λ may also contain harmonics $\lambda/2$, $\lambda/3$, etc., which arise from the white radiation. The reflected radiation is seriously polarized, and this gives rise to difficulties in intensity calculations on reflexions. It was suggested that tube manufacturers should be asked to give some idea of the state of polarization of the X-ray beam from the tubes they supply. For low-angle work a perfect reflector such as calcite, giving a very sharp beam, is better than a mosaic crystal of the penterythritol type.

The discussion was opened by Sir Lawrence Bragg, who urged that if automatic gear is produced it should be really 'foolproof', and that some 'figure of merit' of an X-ray tube should be given by its manufacturers. He also asked that information to the best form of monochromator should be made available. Dr H. Lipson (Cavendish Laboratory, Cambridge) asked for greater co-operation between

designers and users, he stated that the filament life in a Metropolitan-Vickers tube is 300-500 hours. Dr Witty replied that magnetic and electric automatic gear should be 'foolproof', vacuum relays are being improved, but are more of a problem. Dr V T Astbury (Textile Physics Laboratory, University of Leeds) said that the inventing scientific worker gets little return for his efforts and is often himself held up for lack of apparatus. He believed that for further progress in design, automatic gear in experimental tubes should be kept down to a reasonable minimum. Dr E Green (Unilevers, Ltd) directed attention to a Russian X-ray tube in which a spirally-rooved rotating anode acts as its own molecular pump. Mr. H P Rooksby (General Electric Co., Ltd) described briefly a demountable X-ray tube which has been in continuous use at his laboratory for ten years. Dr I MacArthur (Textile Physics Laboratory, University of Leeds) suggested that a monochromator might be placed inside the X-ray tube to produce a maximum intensity. Dr A Taylor (English Electric Co., Ltd) said that from a sealed-off X-ray tube a beam has been obtained in which iron lines have been found present due to the evaporation of iron from a filament lead on to the target of the tube.

Dr W T. Astbury opened the afternoon session with a description of the high-output X-ray tubes which have been developed in his laboratories. The rotating anode tube has been evolved in three stages: it has a rotating copper target with a mercury seal and the body is stainless steel. Two difficulties were anticipated with this type of instrument. The first was the stability of the rotating mercury columns, an equation of the overall height of the mercury meniscus rotating with an angular velocity Ω and internal and external radii a and b is given by

$$h = \frac{\Omega^2 a^4}{g(b^2 - a^2)^3} \left[\frac{b^4 - a^4}{2a^2} - 2b^2 \log_e \frac{b}{a} \right] \approx \frac{\Omega^2 a \delta}{3g} (1 - \delta/2a), \text{ where } \delta = (b - a)$$

Then $\Omega = 500$ r.p.m., then $h = 0.3$ in. for the inner and 0.45 in. for the outer rotating system, which agrees near enough with observations. In the latest instrument $(b - a) = \frac{1}{8}$ in., but this can be reduced and it can be said that the mercury column is stable. The second difficulty is evaporation from the mercury to the vacuum, but this has been eliminated by covering the meniscus with a layer of Apiezon oil, and no contamination of the vacuum chamber or anode then occurs. Dr Astbury described how the instrument was designed as a gas tube, this is then modified to contain a filament source. The first tube was a completely re-designed instrument which ran at 70 milliamperes and 30 kV. This is the output of the high-tension equipment at the moment available, but there is no reason why much higher currents should not be used.

A much simpler and cheaper moving target tube has been designed which will be within the reach of any research worker requiring beams of reasonably high intensity. The instrument is continuously evacuated, and the anode is a flat hollow bar (through which runs the cooling water) which oscillates backwards and forwards at three complete oscillations per second. The vacuum seal is made by means of a rubber bellows at each end. A second and slower motion is given to the bar to vary the position of the instantaneous zero of the main oscillation and thus

prevent the development of hot spots during running. Alternative methods of sealing the vacuum joint of the oscillating anode were suggested. Dr Astbury visualizes a long oscillating tube incorporating a series of anodes all sealed by a single pair of bellows and operated from the same pumping system, and each having two windows. (At the time of the meeting the instrument had not been developed to the stage of giving an X-ray beam, but since that time the tube has run steadily at 45 milliamperes and 30 kV. and very good photographs of ramie have been taken in 2 minutes with a $\frac{1}{2}$ mm collimator and a distance of 2 cm (see *Nature*, 155, 108, 1945).)

Dr I MacArthur reviewed the development of moving-target tubes, and gave special prominence to features such as continuous cooling and vacuum seals in the instruments. The main point is not the overall power of the tube, but rather the maximum loading per unit area of the focal spot. This is determined by focusing, which might be improved by the electron gun method as used by Siegbahn, or by magnetic means. A clean target is also necessary, tantalum filaments were found to be less likely to sputter the anode than tungsten, although they have a shorter life. Dr MacArthur referred to the possible use of the rotating anode as a molecular pump. He warned would-be makers of rotating anode tubes against porosity in vital metal parts.

Replying to questions by the chairman in the discussion, Dr Astbury said that the rotating anode of his tube can be changed easily without draining away the mercury, and that at 70 milliamperes and 30 kV the tube is 8-20 times as fast as a normal Philips tube. Dr Kathleen Lonsdale described the 50 kW and 5 kW moving anode tubes at the Royal Institution. The output of a Shearer tube running at a nominal 5-10 milliamperes and 40-45 kV was given as 400 watts, and a comparison of the speeds of photography of a normal Philips tube, a Shearer tube, and the 5 kW tube was said to be 1:8:24. The Shearer tube was used with a modified Wehnelt break and an induction coil, and a good beam was said to be maintained over a period of four hours.

Mr Stephen said that the load on a Philips tube can be increased, but this will reduce the life of the tube. He asked that collimator sizes should be standardized, and then manufacturers would be able to design tubes for special purposes, at present the normal sealed-off tube has to be used on all occasions. Mr T S Millen (Metropolitan-Vickers Electrical Co., Ltd) outlined the optimum conditions for a rotating anode used as its own molecular pump. Replying to Mr Rooksby, Dr Astbury, Dr MacArthur and Dr Green said that the porosity of the metal in the rotating anode tube is in the outer casing and not in the anode itself. This leakage is closed by coating lightly the affected parts with shellac. Replying to a question of relative positions of focal spots in the Matchlett and Philips tube, Mr Stephen said that with $9\frac{1}{2}$ cm cameras the extra 1 cm distance between focal spot and window in the Philips tube is immaterial, and is necessary because the windows of the Philips tube are of Lindemann glass. Dr A Taylor suggested that alloy targets might be used so that with suitable choice of filters different monochromatic beams might be obtained. Mr F A Bannister (British Museum) told the meeting that minerals can be readily examined using beams from Shearer tubes, the purity of radiation of which is universally accepted.

F. HAPPAY

GRAMICIDIN S

IT is now well known that Dubos and his collaborators in America (see, among other papers by these workers, R. J. Dubos and R. D. Hotchkiss, *J. Exp. Med.*, 73, 629, 1941) obtained from soil, sewage, manure and cheese, several species of aerobic, sporulating bacilli which are antagonistic to unrelated organisms, and that they recovered from these organisms an alcohol-soluble, water-insoluble fraction called tyrothricin, which kills many Gram-positive and Gram-negative organisms. From tyrothricin they isolated two crystalline polypeptides—gramicidin and tyrocidine. Tyrothricin is unsuitable for systemic administration (*Brit. Med. J.*, 122, Jan. 27, 1945), but it is a powerful local antiseptic and has been used for the treatment of wounds, affections of the eye, nose and throat, empyema, certain skin affections and other conditions, not requiring parenteral administration. It is now marketed by Messrs Sharp and Dohme, Ltd., Mulford Biological Laboratories, Hoddesdon, Herts, who issue a booklet on its history and use, with a useful bibliography about it.

Russian workers (*Nature*, 154, 703, Dec. 2, 1944; *Lancet*, 715, Dec. 2, 1944) now report the discovery of another substance of the same kind as the American gramicidin. Prof. G. F. Gause and M. G. Brazhnikova, of the Moscow Institute of Tropical Medicine, report on their search, during 1942, among several hundreds of strains of bacteria from Russian soils for an organism similar to that discovered by Dubos and his collaborators. They often noted action antagonistic to bacteria in their cultures, but only one organism, isolated from garden soil, was remarkably effective. This belonged to the *Bacillus brevis* group and was similar to, but not entirely the same as, the one isolated by Dubos and Hotchkiss (*loc. cit.*). It produced, however, an antibacterial principle which is entirely different from that described by Dubos and his collaborators. This principle readily crystallized out when an alcoholic extract of the acid precipitate of the bacterial culture was poured on to a watch-glass, and it never occurred with the tyrothricin described by the American workers. The Russian authors regard this gramicidin as a new substance, different from other known crystalline polypeptides produced by aerobic sporulating bacteria. They call it 'gramicidin S'. Its antibacterial action against eighteen different strains of *Staphylococcus aureus*, ten strains of *Streptococcus* and against *Diplococcus pneumoniae*, *Clostridium welchii* and *C. histolyticum* is described by Gause and Brazhnikova. Comparison of it with tyrothricin showed that gramicidin S was rather more efficient in killing staphylococci, while tyrothricin killed streptococci and pneumococci more effectively, and gramicidin S was the less selective of the two. On the other hand, while tyrothricin is not effective against any of the Gram-negative organisms studied, as Dubos and Hotchkiss (*loc. cit.*) also found, gramicidin S prevents the growth of and kills "many varieties" of Gram-negative organisms, including *B. proteus vulgaris* and *Bact. coli*, which are common in infected wounds. The former is resistant to many antiseptics including penicillin.

At the same time, gramicidin S is very stable and is not more toxic than tyrothricin, the lethal dose (L.D. 50) for white rats being almost the same. Its antibacterial activity is not destroyed by autoclaving, nor do solutions of it used clinically interfere with

the activity of leucocytes. Treatment by the Russian workers of lacerated wounds of guinea pigs infected with *Cl. welchii* showed that the mortality of the animals thus treated was 5 per cent, while that of untreated ones was 53 per cent. When wounds of white rats were infected with garden soil, 100 per cent of the rats died, whereas, when such wounds were treated with gramicidin S, only 40 per cent died.

In the *Lancet* (*loc. cit.*) the chemistry of gramicidin S is discussed by A. N. Belozersky and T. S. Passhin, and its clinical use is described by Prof. B. G. Sergiev, vice-president of the Medical Research Council of the U.S.S.R. Sergiev describes the results of treatment with gramicidin S of three hundred cases of gunshot wounds of soft tissue, severe burns, abscesses and anaerobic infections. The disappearance of necrotic tissue and appearance of granulations and epithelialization were very rapid. Gramicidin S was also useful for preparing wound surfaces for skin-grafting and for the treatment of empyema, peritonitis and impetigo.

Cytologists will be interested in the statement, in the article by Gause and Brazhnikova, that L. Levinson, of the University of Moscow, claims that gramicidin S favours regeneration of wound tissue and especially "the high nucleic acid content of the cells". If this means that the nucleic acid content of tissue cells is increased, this effect of gramicidin S merits further investigation in the light of E. Stedman's view, discussed in a recent article on the chemistry of cell nuclei (*Edin. Med. J.*, 51, 353, 1944), that nucleic acid exists in nuclei in salt-like combination with histone and that diminution of histone from any cause might set free nucleic acid which, by combining with chromosomins, might form a self-reproducing enzymic system analogous to the viruses with the result that, when growth reached a certain stage, mitosis would follow. Stedman suggests that histone may regulate mitosis (see also E. Stedman and E. Stedman, *Nature*, 152, 566, 1943) and that the decrease of histone below a certain level may in this way render a cell malignant. The origin of histone is not known, but Stedman suggests that the lymphoid tissue may supply it, the nuclei of lymphocytes contain a high percentage of histone and the accumulation of lymphocytes around tumours may represent an attempt to remedy the deficiency of histone which is causing the malignancy. If this conception is correct, the confirmation of Levinson's statement that the cells of tissues treated with gramicidin S have a high nucleic acid content is desirable. For it is conceivable that the reported beneficial effect of gramicidin S upon regeneration of tissue may be due to an increase of nucleic acid caused by gramicidin S, with the result that more is present than the available histone can absorb, so that, as Stedman suggests, the excess combines with chromosomins, and cell divisions, that is, cell proliferation, follow. A further result is, however, conceivable: if gramicidin S treatment were sufficiently prolonged some cells might be started off on a career of malignancy, especially if other factors were already reducing the available histone. It seems unlikely that gramicidin S itself could reduce the histone, but this possibility needs investigation. If, on the other hand, it could increase the histone, it might prove useful for the treatment of malignancy. The possibility that the American gramicidin and tyrocidine may have similar effects is also worth study. Whether similar effects can be exerted by other bacterial or perhaps fungal products can only be answered by the cytologist.

G. LAPAGE

KILN SEASONING VENEERS FOR PLYWOOD MANUFACTURE

DURING the War considerable investigation and research work has been carried out at the Forest Research Institute, Dehra Dun, India, on the subject of plywood manufacture. Kiln seasoning has been studied. Two *Indian Forest Leaflets*, Nos 57 and 61 (published by the Forest Research Institute, Dehra Dun), deal with "Furnace Heated Veneer Drying Kiln" and "Kiln Drying Schedule for Seasoning of Veneers", giving the latest practical information on these subjects. In Leaflet No 57, after directing attention to the necessity of the thorough seasoning of veneers before gluing and manufacture into plywood, it is pointed out that green veneers can be air-seasoned or kiln-dried, exactly like ordinary wood. The usual method in Europe and America for the quick seasoning of veneers is to dry them in long progressive dryers. This well-known type of dryer is very expensive, the pre-war price being more than 0,000 rupees.

Apart from the considerable price, it was found that this dryer was not essential for the quick seasoning of veneer, especially for the cheaper forms of plywood in so great demand in India, and that cheaper forms of timber seasoning kilns could be used. Experiments in this direction were undertaken and resulted in the furnace-heated veneer-drying kiln described. This is an indirect-heated internal-fan furnace kiln, suitable for the rapid seasoning of veneers before manufacture into plywood. It has been primarily designed for the use of plywood factories in which there is no provision for the supply of steam. The kiln has plenty of heating surface to raise the temperature of the circulating air in a short time. It is provided with four fans for the rapid circulation of air necessary for successful veneer drying. Provision is made for exhausting the moist air of the kiln through chimneys in the roof and for drawing in fresh air through the fresh-air ducts. The kiln is also provided with tracks and trucks, the latter of which are loaded with the green veneers outside and then pushed along the tracks into the drying chamber. It is estimated that 1/16 in thick veneers of mango take about three hours for complete seasoning, as compared with a few minutes in the costly long progressive dryers of Europe and America. The cost of installation of the one described is estimated at about 5,000 rupees, at July 1943 current prices.

In Leaflet No 61 the results of experiments carried out on the kiln seasoning of veneers of mango (*Mangifera indica*), salai (*Boswellia serrata*), narikel (*Coccotheca alata*) and sissoo (*Dalbergia sissoo*) are briefly described. From the results obtained for the first three of the above species, a kiln-drying schedule for the seasoning of veneers of light hardwoods, commonly used for cheap plywood, is recommended. A short description of different kinds of veneer dryers also included.

RESEARCHES IN PLANT VIRUS DISEASES

SEVERAL workers at the Rothamsted Experimental Station have recently added to our knowledge of plant virus diseases. A Kleczkowski (*Biochem J*, (2), 38, 160, 1944) has found that tobacco mosaic virus does not combine with pepsin until it

has been denatured by heat. Potato virus X, however, is a substrate for the proteolytic activity of pepsin, and combines with it. The same virus is also a substrate for trypsin, which nevertheless combines more with tobacco mosaic virus, which is not a substrate. This action can explain the reversible inhibition of tobacco mosaic virus by trypsin. Invertase does not combine with either virus.

F C Bawden and N W Pirie have found (*Brit J Exp Path*, 25, 68, 1944) that extracts of milled fibre from tomato plants infected with bushy stunt contain some virus combined with chromoprotein to form a non-precipitating antigen. The extracts would, however, precipitate with antiserum when the chromoprotein had been removed. Extracts from healthy plants to which pure virus is added are also non-precipitating.

B Kassanis (*Brit J Exp Path*, 24, 152, 1943) has studied the mechanism of neutralization of infectivity of several viruses by antisera. Unspecific neutralization by normal and heterologous sera is great in proportion to the additional specific effect of homologous antisera. Specific neutralization could only be used to demonstrate serological relationships if sera were of the same age and subjected to comparable storage conditions. Neutralization is not caused by precipitating antibodies, and precipitin titre is not correlated with neutralizing power. Specific antisera for the sugar beet yellows virus have been prepared by A Kleczkowski and M A Watson (*Ann Appl Biol*, 31, 2, 1944). The virus is not affected between pH 5 and 9, though it is relatively unstable. It has not yet been purified, though it is reversibly precipitated by ammonium sulphate, and sedimented by high-speed centrifugation. The precipitin reaction with antisera can be applied to the crude sap, and is useful for diagnosis. Several workers have claimed that virus inactivation by formaldehyde and mercuric chloride is reversible, but B Kassanis and A Kleczkowski (*Biochem J*, 38, 20, 1944) have not found this to be so with purified tobacco mosaic virus. Inactivation could be arrested at any stage by dilution or dialysis, but could not be reversed. Loss of infectivity caused by formaldehyde does not seem to depend on changes in amino-nitrogen groups.

Serological reactions and the production of intracellular inclusions have been used by F C Bawden and F M L Sheffield (*Ann Appl Biol*, 31, 33, 1944) to establish relationships between viruses causing necrotic diseases of the potato. Potato virus B, and some others not previously described, are strains of virus X, and potato virus C is a strain of virus Y. Virus A is not related to Y or X.

FORTHCOMING EVENTS

(Meeting marked with an asterisk * is open to the public)

Saturday, February 24

NUTRITION SOCIETY (at the London School of Hygiene and Tropical Medicine, Keppel Street, Gower Street, London, W C1), at 11 a.m.—Discussion on "Factors Affecting the Nutritive Value of Bread as Human Food".

BRITISH PSYCHOLOGICAL SOCIETY (in Room 134, Tuke Building, Bedford College for Women, Regent's Park, London, N W 1), at 2.15 p.m.—"Training Industrial Workers" (a) Pearl H. M. King "Some Suggestions for the Development of Personality through Industry", (b) Helen Turner "Proficiency and Skill on the Job", at 4.30 p.m.—P. M. Freeston "Children's Conceptions of Adult Life", at 5.15 p.m.—Madeline Kerr "The Functions of Visual Imagery in the Formation of Stereotypes".

ASSOCIATION FOR SCIENTIFIC PHOTOGRAPHY (at Caxton Hall, Westminster, London, S W 1), at 2.30 p.m.—Mr D. R. Barber and Mr E. H. Amstein "Factors Influencing the Choice of Photographic Materials for Use in Quantitative Spectrography".

INSTITUTION OF MECHANICAL ENGINEERS (GRADUATES' SECTION) (at Storey's Gate, St. James's Park, London, S W 1), at 3 30 p.m.—Mr N Hanlon "The Problems involved in the Establishment of a Large Works in a Country District"

Monday, February 26

ROYAL GEOGRAPHICAL SOCIETY (at Kensington Gore, London, S W 7), at 5 p.m.—Prof H W Ahlmann "Summary of Glaciological Researches, 1918-1940"

INSTITUTION OF ELECTRICAL ENGINEERS (at Savoy Place, Victoria Embankment, London, W C 2), at 5 30 p.m.—Discussion on "Location of Industry" (to be opened by Mr D B Williamson)

Tuesday, February 27

ROYAL ANTHROPOLOGICAL INSTITUTE (at 21 Bedford Square, London, W C 1), at 1 30 p.m.—Lieut-Colonel D L R Lorimer "Scenes from the Life of a Noniad People—The Bakhtiari of S W Persia"

INSTITUTION OF BRITISH AGRICULTURAL ENGINEERS (at the Institution of Electrical Engineers, Savoy Place, Victoria Embankment, London, W C 2), at 2 p.m.—Mr C A Cameron Brown "Internal Farm Mechanisation"

ROYAL INSTITUTION (at 21 Albemarle Street, London, W 1), at 5 15 p.m.—Sir George Dyson "The Origin and Development of Early Musical Forms", (3) "The Age of Bach and Handel"

ILLUMINATING ENGINEERING SOCIETY (joint meeting with the ROYAL INSTITUTE OF BRITISH ARCHITECTS) (at the Institution of Mechanical Engineers, Storey's Gate, Westminster, London, S W 1) at 5 30 p.m.—Dr J W T Walsh "The Relationship between Interior Design in Building and Artificial Illumination"

INSTITUTION OF CIVIL ENGINEERS (ROAD ENGINEERING DIVISION) (at Great George Street, Westminster, London, S W 1), at 5 30 p.m.—Mr F N Sparkes and Mr A F Smith "The Concrete Road, a Review of Present-day Knowledge and Practice"

TELEVISION SOCIETY (at the Institution of Electrical Engineers, Savoy Place, Victoria Embankment, London, W C 2) at 6 p.m.—Dr H P Williams "Vertical v Horizontal Polarisation"

SHEFFIELD METALLURGICAL ASSOCIATION (at 198 West Street, Sheffield 1) at 6 30 p.m.—Lord Halsbury "Safety Pins and Swords"

Wednesday, February 28

ROYAL SOCIETY OF ARTS (at John Adam Street, Adolph, London, W C 2), at 1 45 p.m.—Prof E P Stebbing "Erosion and Water Supplies"

INSTITUTION OF ELECTRICAL ENGINEERS (RADIO SECTION) (at Savoy Place, Victoria Embankment, London, W C 2), at 5 30 p.m.—Mr D I Lawson "Multipath Interference in Television Transmission"

INSTITUTE OF WELDING (at the Institution of Civil Engineers, Great George Street, Westminster, London, S W 1), at 6 p.m.—Mr R J Cross "Design and Fabrication of Welded Magnesium Alloy Aircraft Tanks"

ASSOCIATION OF SCIENTIFIC WORKERS (HUDDERSFIELD BRANCH) (in the Technical College, Huddersfield), at 7 30 p.m.—Dr D G Drummond "The Electron Microscope"

Thursday, March 1

ROYAL INSTITUTION (at 21 Albemarle Street, London, W 1), at 5 15 p.m.—Sir Lawrence Bragg, F.R.S. "Some Physical Problems of the Solid State"

INSTITUTION OF ELECTRICAL ENGINEERS (at Savoy Place, Victoria Embankment, London, W C 2), at 5 30 p.m.—Mr P Richardson "Stray Losses in Synchronous Electrical Machinery"

ROYAL AERONAUTICAL SOCIETY (at the Institution of Mechanical Engineers, Storey's Gate, St. James's Park, London, S W 1), at 6 30 p.m.—Mr M B Morgan and Mr Thomas "Control Surface Design"

Friday, March 2

SOCIETY OF CHEMICAL INDUSTRY (PLASTICS GROUP) (at Gas Industry House, 1 Grosvenor Place, London, S W 1), at 2 30 p.m.—Dr J C Swallow "Some Aspects of Research in the Plastics Industry"

ROYAL INSTITUTION (at 21 Albemarle Street, London, W 1), at 5 p.m.—Mr H L Kirke "Some Aspects of Pre-War and Post-War Television"

Saturday, March 3

GEOLOGISTS' ASSOCIATION (at the Geological Society of London, Burlington House, Piccadilly, London, W 1), at 2 30 p.m.—Annual General Meeting Mr A S Kennard "The Early Digs in Kent's Hole, Torquay, and Mrs Cazalet" (Presidential Address)

APPOINTMENTS VACANT

APPLICATIONS are invited for the following appointments on or before the dates mentioned.

LECTURER IN THE DEPARTMENT OF CHEMISTRY—The Principal, Derby Technical College, Normanton Road, Derby (March 5)

LECTURER IN BIOLOGY—The Director, School of Pharmacy, Robert Gordon's Technical College, Aberdeen (March 6)

BOROUGH SURVEYOR AND ENGINEER—The Town Clerk, Guildhall, Shrewsbury (endorsed "Borough Surveyor") (March 9)

FOOD AND DRUG ANALYST for service with large Company operating in the Middle East—The Ministry of Labour and National Service, Appointments Department, Central (T and S) Register, Room 5/17, Sardinia Street, Kingsway, London, W C 2 (quoting Reference No F 2894 XA) (March 12)

ASSISTANT LIBRARIAN—The Secretary, Royal Society of Medicine, 1 Wimpole Street, London, W 1 (March 15)

RESEARCH INVESTIGATOR to take charge of the section of the Research Department dealing with the CASTING OF NON-FERROUS METALS AND ALLOYS, and a RESEARCH INVESTIGATOR to take charge of the section of the Research Department dealing with the CORROSION OF METALS—The Director, British Non-Ferrous Metals Research Association, Euston Street, London, N W 1 (March 31)

PROFESSOR OF PHILOSOPHY, tenable in the Durham Division of the University—The Registrar, University of Durham, 46 North Baile Durham (March 31)

KEEPER OF THE DEPARTMENT OF ANTIQUITIES—The Registrar The University, Old Clarendon Building, Oxford (March 31)

LIBRARIAN—The Acting Registrar, Queen Mary College, c/o Kin, College, Cambridge (April 3)

LECTURESHIP IN GENETICS—The Secretary of University College The University, Glasgow (April 7)

HEAD OF THE DEPARTMENT OF HOUSEHOLD ARTS—The Secretary King's College of Household and Social Science, c/o University College Leicester (April 14)

SECRETARY AND REGISTRAR—The Acting Registrar, University College of North Wales, Bangor (April 21)

PROFESSORSHIP OF MECHANICAL AND MARINE ENGINEERING, tenable at King's College—The Registrar, King's College, Newcastle upon Tyne (April 30)

SECRETARY—The Council, Institution of Naval Architects, Upper Belgrave Street, London, S W 1 (May 1)

LIBRARIAN—The Secretary and Treasurer, University College Dundee (August 31)

MASTER to teach CHEMISTRY and subsidiary PHYSICS to Scholarship standard—The Acting Head Master, Perse School Cambridge

SPEECH THERAPIST—The Education Officer, County Hall, Wakefield

SPEECH THERAPIST—The Director of Education, Education Office Moss Street, Bury, Lancs

PSYCHOLOGIST (part-time, man or woman)—The Medical Superintendent, Mill Hill Neurosis Centre, Mill Hill, London, N W 7

GRADUATE MASTER or MISTRESS to teach Inter B Sc CHEMISTRY to Evening students and SCIENCE or MATHEMATICS in Junior DE Departments—The Principal, Wycombe Technical Institute, East Street, High Wycombe, Bucks

TEACHER (full-time) of METALLURGY, with CHEMISTRY as a subsidiary subject—The Principal, Enfield Technical College, Queensway Enfield, Middx

LECTURER IN GEOGRAPHY—The Secretary, Homerton College, Cambridge

GEOGRAPHY SPECIALIST (part-time, or full-time if able to offer second subject which may be required)—The Principal, Diocese Training College for Women Teachers, Ripon, Yorks

HEADMASTER OF OUNDLE SCHOOL—The Secretary to the Governors, Body, Grocers' Hall, Princes Street, London, E C 2

ASSISTANT DAIRY BACTERIOLOGIST—The Principal, Harper Adams Agricultural College, Newport, Shropshire

REPORTS and other PUBLICATION

(not included in the monthly Books Supplement)

Great Britain and Ireland

Race Relations and the Schools. A Survey of the Colour Question in some Aspects of English Education, with a Number of Proposals and Questions. Pp 56 (London League of Coloured People 1945) [2]

The Future of University and Higher Education. A Report prepared by the National Union of Students of the Universities and Colleges of England and Wales. Pp 16 (London National Union of Students 1945) 6a [2]

Leeds University. Report to the Worshipful Company of Clothworkers of the City of London of the Advisory Committee on the Departments of Textile Industries and Colour Chemistry and Dyeing during the Session 1943-44. Pp 30 (Leeds The University 1944) [3]

The Road to Security. By Prof David Mitrany. (Peace Air Pamphlet, No 29) Pp 20 (London National Peace Council 1944) 4a [3]

Imperial College of Science and Technology. Proceedings of the Conference of Industrial Representatives, No 2. Industry at University Education, convened by the Vacation Work Committee of the Imperial College Union, London, on 15th December 1944. Pp v+40 (London Imperial College of Science, 1945) [3]

Other Countries

Kungl Svenska Vetenskapsakademien Handlingar. Serien 3, Band 21, No 4. Die Samenbildung und die Zytologie bei Agamosperischen und Sexuellen Arten von Elatostema und einigen Naherhenden Gattungen nebst Beleuchtung einiger damit zusammenhängender Probleme. Von Folke Lagerlund. Pp 130. Serien 3, Band 21, No 5. A Quantitative Study of the Reflexion of X-rays by Sodium and Potassium Chlorides. By J A Wasasterna. Pp 21. Serien Band 21, No 6. The Anatomy of *Latostomella gislénii* Sién (Bryozoa Protozoostomata), with special regard to the Embryo Chamber of the Different Groups of Bryozoa and to the Origin and Development of the Bryozoan Zoarium. By Lars Sién. Pp 111+5 plates. Serien 3, Band 21, No 7. On the Eoskeletal Shoulder-girdle Teleostomian Fishes, with special reference to *Eusthenopteron forbesi* Whiteaves. By Erik Jarvik. Pp 32 (Stockholm Almqvist & Wiksells Boktryckeri A-B, 1944) [1]

Catalogues

The B.T.L. Photoelectric Turbidimeter and Colorimeter. Pp The B.T.L. Universal Electric Sturmer. Pp 8 (London Baird & Tatlock Ltd)

A Catalogue of Books Old and Modern in various Departments Literature (No 497) Pp 38 (Cambridge Bowes and Bowes, Ltd 1945) 3d

NATURE

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FUNCTION, OF INFORMATION SERVICES IN GOVERNMENT

THE debate in the House of Lords on January 31, on Lord Elton's motion, regarding the setting up of an organization to assume after the War the responsibility for spreading knowledge of the British Empire, a duty which is at present undertaken by the Ministry of Information, touches one particular aspect of the wider problem discussed in the Political and Economic Planning broadsheet on "Government Information Services" issued a couple of days later. The debate, in which others besides Lord Elton paid tribute to the work of the Empire Information Service, amply demonstrated the need for such educational work, as well as the opportunities, and Lord Samuel and Lord Hailey lent powerful support to Lord Elton's plea that plans should be made for continuing the work of this unit if the general work of the Ministry of Information should be brought to an end. There was division of opinion as to how best this could be achieved. Lord Elton and Lord Hailey both suggested a form of Empire Publicity Board, with strong independent representation, in association with that of Government departments, and though Lord Cranborne in replying for the Government pointed out weaknesses in such a proposal, he indicated that the importance of the question is fully appreciated by the Government and that it has been for some time under the urgent consideration of the departments concerned.

The *Planning* broadsheet is concerned with the more general aspects of the question and is a sequence to an earlier broadsheet on "The Future of Foreign Publicity" which has already been discussed in these columns. It was assumed in the House of Lords debate and also in the broadsheet on information services that the Ministry of Information will be terminated at the end of the War, and though this appears to be accepted as right and proper, there was strong support for the view that certain of its activities should be continued in some way under Government auspices. Powerful support is to be found for this point of view in two recent and important books. Sir Victor Wellesley, in "Diplomacy in Fetters", discusses the handicaps under which foreign policy is conducted by a democracy, and makes two points which are vital to the discussion of this subject. First, the danger which uninstructed public opinion represents in the conduct of foreign affairs, and secondly, that if the maintenance of a lasting peace is the chief objective of our foreign policy, it is essential that domestic policy should conform to the exigencies of foreign policy, and vice versa. Sir Victor proceeds to outline some constructive proposals, based on his experience as Deputy Under-Secretary of State for Foreign Affairs, to provide a new technique by which policy could keep abreast of modern requirements. With its details we are not concerned here, more than to emphasize that it involves more accurate intelligence on foreign affairs—not merely fact-finding—as a basis

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for the determination of policy, and also the education of public opinion

Mr McCallum's "Public Opinion and the Last Peace" contains no such constructive proposals, but his review of the changes in public opinion with regard to the problems arising out of the Treaty of Versailles and the way in which these contributed to the disaster of 1939, demonstrates once again the dangers of an uneducated public opinion and also of the absence of clear, straight thinking on the part of statesmen and party leaders. Once again it is apparent that courage and honesty are the foundations of effective policy, and there could scarcely be more emphatic evidence of the importance of some official effort to guide public opinion as to what is involved in public measures and policies than in these two books.

The *Planning* broadsheet drives home the same lesson, though from another point of view. The conception of government as a positive and not a merely negative function plays in this, as in other *Planning* broadsheets, an important part in leading up to the conclusions which are drawn: the Government cannot perform its larger functions in the social and economic life of the community unless it has the right and means to make its purposes and methods effectively known. That need cannot be wholly met by full reporting of Parliamentary debates, and it is high time, in consonance with democratic principle, that fuller and simpler explanations be given to the great majority of people, who have a right to know why and what their Government has done, is doing and wishes to do. Explanation cannot be left entirely to the initiative of newspapers and book publishers: the administration is entitled in the public interest to take its own view of what requires explanation and by what means the explanation can best be given. Equally it is important that Government should be kept continuously aware of the citizen's point of view.

The P E P Group which has produced "Government Information Services" has admirably fulfilled its set purpose of adding to public knowledge of this important aspect of government, evaluating criticism and drawing up recommendations for the future. The history of Government public relations departments is briefly reviewed, and the lucid analysis of current criticism and of future activities leads to proposals for their future scope and organization which are concisely summarized. While there is nothing very novel in these recommendations—the Group agrees on the whole with the view that the end of the War should see the end of the Ministry of Information—the need is emphasized for an early decision by the Government as to the way in which certain of the functions of the Ministry are to be perpetuated. Just how the centralized responsibility for public information should be discharged in peacetime may be a question to which the answer can best be found in practice. The broadsheet shows clearly that the function of Government information is not exhausted even in the adequate performance by administrative departments of their own functions.

The first P E P recommendation is that Government information services should continue after the War through departmental units. Their functions should include the provision of news and information about administrative activity and the background of policy, public instruction on appropriate themes, and advice to their Ministries on public attitudes and opinions. To avoid misunderstanding and to keep present to the minds of the officers themselves the essential nature and the proper limits of their task, the term 'public relations' should be dropped and 'information' substituted. To provide technical and creative services, P E P recommends that a central publicity unit should be set up, attached to the Treasury, the Lord President of the Council or the Cabinet Offices, and operating under the general direction of a standing committee of departmental directors of information services. The unit would take over the work of such divisions of the Ministry of Information as films, publications, photographs, exhibitions and campaigns, and be responsible for buying space, time and commodities for all Government advertising. In the production of publicity, departments should be free to deal direct with private agencies where these exist.

With regard to themes, it is suggested that, as before the War, information units should undertake publicity on such questions as health and road safety, and should also provide information about new post-war measures and policies. Fuller background information should be given on subjects of general interest such as foreign affairs and public finance. Food and works relations publicity should also continue, the latter under the joint sponsorship of Government, employers' organizations and the trade unions, with considerable devolution of control to the level of industries and factories. If the inherent dangers and difficulties can be overcome, information services in this field might do something materially to improve industrial relations and to promote the closer integration of industry with the community it serves. Furthermore, information services should cover the general nature and methods of the Civil Service and its work. A fuller and wider knowledge of the facts and reasons on the part of the public would both be a safeguard against bureaucracy and prejudiced criticism of the Civil Service and accelerate any necessary or desirable changes in the Service itself. The more light is thrown on the purposes and methods of Government departments, the less likely are obsolete techniques, sectional habits of thought and indifference to the service of the public to survive. Moreover, it cannot be doubted that if considerable changes in the machinery of government at any level prove necessary to serve our new needs, public understanding and consent will be indispensable before such changes can be implemented.

With regard to departmental arrangements, the broadsheet urges that the head of the departmental branch should have sufficient status to give him access to the Minister, and adequate authority in negotiation and conference, a rank of at least assistant secretary is proposed. While the size and

iversity of the staff must depend on the size and ork of the Ministry, in general large technical staffs could be avoided; a small highly-qualified staff able to use outside services, with a chief of high Civil service rank, is preferred. The director himself need not be a technician, but should be well qualified to direct and control the technical services involved. Initially, directors might be chosen from outside, sometimes on a temporary basis; but in due course these posts could be filled by Civil Servants with the right aptitudes and some experience in information branches.

The broadsheet also directs attention to the value of close links between information branches, departmental intelligence units and libraries. In the Ministry of Health, these have from their inception been organically related, but in other Ministries relations are casual, and there may be no functional or administrative relation between public relations and the library, the statistical branch and the intelligence branch or any of them. Indeed the broadsheet goes so far as to suggest that if Whitehall had before the War been staffed with public relations branches which knew their business, the neglect of statistics and research which marred the administrative work of some Departments of State might in part have been corrected. At this point some clear thinking will obviously be required if the proposals are not to conflict with those which have been advanced by the Council of the Royal Statistical Society in its memorandum on official statistics and which, as the Prime Minister has announced, are now to be discussed with representatives of the departments concerned at a special meeting.

Another subject which calls for further consideration is the provision of information about public opinion. The first and most important source of such information is Parliament, but the Parliamentary interpretation of public opinion needs to be supplemented, as it has been during the War, by scientific surveys of public opinion. This need may arise from administrative considerations—the Requisitioned Land and War Works Bill is a glaring instance of the consequences of administrative neglect in this respect—and while these needs may sometimes be served by limited *ad hoc* inquiries, there is little doubt that more elaborate and fundamental researches may sometimes be required.

The broadsheet is emphatic that the Government should not be deprived of the use of scientific research in this field, but is hesitant as to the method and safeguards. The results of such studies should be published, though delay might sometimes be desirable. Tentatively, it is suggested that the right answer might be to encourage the formation of a social research council or institute under the aegis of the Lord President, financed by the State, but with independent scientific status. Such a body might align itself with the work of the universities and private agencies in this field and could take charge of the official research unit. The broadsheet rightly points out that the public opinion survey represents a new and important method of investigation in the social sciences, of which

the Government should not be wholly deprived; this should be sufficient answer to criticism about interference with civil liberties and spying into private affairs which have been made.

Local information services are important and should be remembered in connexion with the training of local staffs of central departments. The work of the Citizens' Advice Bureaux and the war-time local information centres should continue, the latter should cover the whole province of local government and should keep in touch with the local offices of the Government. Some regional co-ordination by the central Government of its own local information activities will probably be necessary, and the machinery for this could be attached to the central publicity unit.

Finally, reviewing the safeguards against the abuses to which Government information services might be subject, such as their use to press a Government case unduly against opposition, to give unfair advantage to a political party in power, to build up the personal reputations of Ministers, and to overweight the position of the executive *vis-à-vis* Parliament, the broadsheet points to the remedies in due publicity for the nature and operations of the information services themselves, the maintenance of proper codes and standards of conduct among the information staffs, responsible use of them by Ministers, and continuous vigilance by Parliament and the Press.

The careful examination of these dangers and safeguards in the broadsheets does not warrant pessimism as to their adequacy. Vigilance undoubtedly will be required, but an independent central publicity unit as suggested may be free from some of the dangers of departmentalism and be competent to make its contribution in that important field of policy-making which increasingly calls for the work of committees of Ministers dealing with wide general spheres. This is the reason for the suggestion that the standing committee of public relations or information officers should meet under the auspices of the Cabinet Office with a secretary provided by that Office, and that the central publicity unit should be similarly affiliated. Whether or not such developments in the direction of a Civil general staff come soon or late—for there is little doubt they will come—there can be no question that Government information services rightly organized and wisely handled have an important if not an indispensable part to play in the establishment of right relations between knowledge and power, the application of scientific and technical knowledge to public policy, the elimination of prejudice and passion and the harmonization of executive action and public opinion. Scientific workers who study this lucid broadsheet, with Lord Woolton's observations at the recent British Association Conference in mind, can scarcely miss the implications it holds for one of the central problems of to-day, namely, the question as to how best the results of scientific inquiry can be translated into public policy for the general welfare of the community.

INDIVIDUALITY IN HIGHER ORGANISMS

The Biological Basis of Individuality

By Prof Leo Loeb Pp xii+711 (Springfield, Ill., and Baltimore, Md. Charles C Thomas, London Baulière, Tindall and Cox, 1945) 10 50 dollars

THE origin and scope of this book are perhaps best indicated by the following paragraphs from the preface "The starting point of this analysis was a series of investigations on the transplantation of normal and tumour tissues which the author and his collaborators have carried out in the course of about forty-eight years, some of which, especially those dealing with inbred strains of mice, have not yet been published To make possible a unified account and interpretation of the various aspects of individuality, it was necessary for one person to undertake this work, rather than to edit a collective book written by specialists in the different sciences which contribute the data needed for this purpose The method thus chosen suffers from the difficulty that a single author may not be able to treat with equal competence the problems involved, but it is believed that the unified presentation of these fields may, to a certain extent, compensate for such a deficiency

"In the following chapters these types of individuality are analysed as to their evolution and their biological and physical manifestations

"It is hoped that this presentation may be of interest to the biologist and to the general pathologist and that certain parts of it may be helpful even to the surgeon in the practice of tissue grafting, to the geneticist, to the student of cancer and to the immunologist, perhaps also to the psychologist and to some philosophers"

There is, however, much more in the book than might be gathered from these introductory remarks as it is, in fact, a serious and lengthy treatise on the whole subject, including its history and later developments These are gone into in very considerable detail and a valuable bibliography, brought up to 1943, of some eleven hundred and fifty books and papers is appended

Within the limits of a short review it is obviously not possible to give more than a general idea of a work of this size, but some points may be noticed

In the first place, as the term 'individuality differential' and other 'differentials' are constantly used throughout the book and, as the sense in which they are used by the author may not be immediately apparent to the reader of this review, a few words on their meaning may not be out of place It is now known that there is inherent in every higher individual organism something differentiating it from every other individual, which can be discovered by observing the reactions of certain cells and tissues belonging to one individual towards the tissues and cells of another individual of the same species This particular characteristic the author names the 'individuality differential', which is common to all (or almost all) the various tissues and organs of the individual In the same way there are species-, genus-, order-, class-differentials which, together with the individuality differentials, he designates as 'organismal differentials', among which the individuality differential is the highest and finest one

There are two principal methods by which the organismal differentials in general can be analysed (1) by various types of transplantation, and (2) by

serological methods The author and his collaborators have concerned themselves principally with the former method, which he regards as best suited for the investigation of the individuality differential A very large number of transplantations of various tissues into different animals are described and discussed in detail The subjects dealt with in this way include autogenous and homoogenous transplantations in various species, the individuality differential of closely inbred animals, the problems and criteria of success or failure in transplantation of tissues and organs, transplantation of tissues into the allantois (chick embryos, into the brain or into the anterior chamber of the eye The local and general reaction of the host to the transplanted tissues have also been investigated and critically discussed

Interesting chapters deal with the phylogenetic and ontogenetic development of individuality, and with transplantation and individuality in certain invertebrates and lower vertebrates

Another section of the book is concerned with the nature of tumours, with a comparison between the results of the transplantation of tumours and of normal tissues The influence of heredity and of immunity on the results of such transplantations are also discussed

In evaluating the results of transplantation experiments for the analysis of the individuality differential, the author classified these into six grades according to the degree of reaction provoked in the host by the graft and, while admitting that the method can claim only approximate exactitude, he regards it as still very helpful in comparing the results obtained if different types of individuality differentials are made to interact

As regards serological methods, although these have not engaged the practical attention of the author to the same extent as transplantation, they are very fully dealt with in chapters on the blood groups and heterogenetic antigens, the differentiation of individuality differentials by serological methods, idiosyncrasy and anaphylaxis, and the chemical nature of organismal differentials, etc

There is one point on which the reviewer cannot see eye to eye with the author He says that, "While the serological tests are especially useful in the analysis of the differentials of groups of animals, such as species, genera, orders, and classes, transplantation experiments are best suited for the analysis of the differences between individuals as expressed in their individuality differentials" (p 6), and that "serological tests are only under very restricted conditions serviceable in the detection of finer differences" (p 8). Up to the end of last century this may have been the case, but the discovery of the isolyms by Ehrlich and Morgenroth in 1900, by eliminating species and similar complicating factors, enabled attention to be concentrated on the finer differences, and later work showed that, at any rate in certain species (for example, cattle and fowls), it is possible by means of comparatively simple serological reactions to identify with ease and certainty any one individual out of a large group of individuals of the same species, provided that none of these is closely related, thus demonstrating the extraordinarily delicate nature of these reactions The objection, that only one kind of cell (the red blood corpuscle) is used, is met by the definition of the individuality differential which postulates the presence of this differential in all, or almost all, the cells and tissues of the individual

A perusal of the very full and interesting chapter on the chemical nature of organismal differentials will probably convince most readers that future advances in the subject are to be looked for as the result of the efforts of serologists and chemists working in collaboration.

The author concludes with several chapters on more general aspects of the subject, dealing with psychical-social individuality, individuality and the world, and the evolution of individuality. These, however, come more within the sphere of philosophy and are outside the competency of the reviewer.

This book, which embodies the life-work and thought of its author, and includes a critical and almost encyclopædic account of the work of others, will be invaluable to all workers on the subject of individuality and, in view of the wide field covered, will greatly interest many of those working on allied subjects, as suggested in the preface.

C TODD

STIMULATING INDUSTRIAL ENTERPRISE

Refrigeration in the Engineering Industry

Pp. xi+69 (typescript) (London: O. W. Roskill and Co. (Reports), Ltd., 1945) 42s

IT is generally agreed that in the industrial organization which will follow the War it will be necessary for each manufacturer to take full advantage of any technological advances which may be applicable to his particular work. The object of the present report is to help manufacturers of refrigerating plant by pointing out to them some of the fields in which refrigeration can be applied, and conversely to help those engaged in industrial processes where refrigeration would be helpful.

The first suggestion which is offered relates to the maintenance of upper-air conditions in rooms where tests or development of aeronautical instruments, engines or components may be carried out. Here, it is evident that no one wishing to test such appliances under conditions approximating to those which they will meet in service would overlook the need for refrigeration, though it is possible that refrigerating engineers might overlook the special needs, and the potential market, of this application. What the report does is to describe, in not very great detail, the installations which have already been set up for this purpose.

Another application is to the age-hardening alloys. As is well known, after heat treatment, these alloys alter in constitution at temperatures so low as ordinary room-temperature, in many cases it is essential to use them before the age-hardening has taken place, which often means, within two hours of the heat treatment. Now, by storing them at really low temperature, the age-hardening can be delayed, so that it becomes possible to store the articles for periods of the order of a week. The obvious gain to a manufacturer, who needs, say, a stock of rivets, is immense, if he is relieved of the necessity of matching the supply always to the demand.

There is another metallurgical field in which refrigeration may be of use, namely, in the ageing of iron and steel castings, either by removal of mechanical stresses or by accelerating the changes in constitution which occur when the metal is cooled.

There is some divergence of practice in this subject, and the conclusions reached by several workers are outlined in the report. It is noticeable that all the descriptions and references are taken from the work of practical engineers, that of physicists and the more academic metallurgists being ignored. It is probable that more careful consideration of their results and conclusions would either reconcile or explain the divergences of practice mentioned.

The older method of making a shrink fit is to heat the member which is too small until it just fits the other, obviously, where the one that is too large is more easily manipulated, refrigeration can help by providing means of cooling this member until it fits the smaller. Examples of this method are given, and will no doubt suggest other cases to enterprising readers.

This part of the report closes with an account of the attempts which have been made to apply local cooling to welding-electrodes, and of other miscellaneous applications, one of which (the desiccation of air supplied to furnaces) is simply a special application of the problem of air-conditioning, an art which refrigeration engineers have certainly not neglected in the past few years.

The second part of the report reviews refrigeration plants themselves, mentioning what has been done to produce multi-stage machines and to make absorption and cold-air machines practicable. Its value will therefore be mainly to the manufacturer, and less to the purchaser or prospective purchaser of a plant, though the latter may benefit by having this conspectus of types available, and may be enabled to put his inquiries direct to a firm specializing in the kind of machine best suited to his problems.

From this account, it will be seen that the report, while offering suggestions for new work or methods of working, to manufacturers and others, does not make new, original suggestions, but simply displays for consideration the more novel processes or devices already used and described. Clearly this is a legitimate activity for business consultants to engage in, and it is apparently found to be useful, for this is at least the fourth report published by the same firm. At the same time, if these reports are useful, the question presents itself whether a much larger series, covering indeed all the main branches of technology, may be needed, and whether it would be better undertaken as a definite series under the guidance of some such body as one of the engineering institutions.

Chemists already have reviews of this sort, one for pure chemistry and one for applied, while physicists have the "Progress Reports" and the (American) *Physical Reviews*. All these publications find a ready sale, and it is at least possible that similar reviews, in which an engineer engaged in one part of the industry might rapidly survey the advances in other parts, would be equally valuable. Another means by which engineers could be kept in touch with advances in regions other than their own would be an abstract journal, but experience seems to show that engineers are not attracted by these.

If either a journal of reviews or one of abstracts is desirable, it is clearly for engineers to say which they want, how detailed the reviews should be, and how the journal should be directed. It is to be hoped that some responsible body will take up this inquiry. Meanwhile, reports such as the one under review will help to show what could be done.

J. H. AWBERRY.

NAMING OF THE REDWOODS

By PROF J DOYLE

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A GENERIC segregation of the two redwoods has recently been proposed by Buchholz¹ on grounds to be referred to later. The coast redwood, with obvious priority claim to the name *Sequoia*, remains *Sequoia sempervirens*. A new generic name *Sequoiadendron* has been proposed for the Sierra redwood, long known as *Sequoia gigantea*. Buchholz¹ rejects the possible use of *Wellingtonia* as it was earlier used, though afterwards discarded, for one of the Sabiaceae and is thus a later homonym. In a later paper Looby and Doyle² expressed a general agreement with the advisability of a segregation, though they were not attracted by the choice of the new generic title. Now in many quarters, especially in California, a body of opinion objects to any change in the name of the Sierra redwood, desiring the retention of *Sequoia gigantea*. In a discussion of this subject in *Science*, Jones³ quotes extensively from this paper by Looby and Doyle as scientific support for the necessity of a segregation and refers to the authors as botanists "who, presumably, may be safely considered free from any motives ulterior to the spirit of scientific enquiry." Having been thus dragged, as it were, on the arbitration board dealing with this vexed question, a further personal statement may be permitted.

This question of the generic segregation of the Sequoias has been in mind for a long time. It was discussed, for example, with Dr Florin of Stockholm when he visited Ireland in 1938, but at that time the evidence did not seem convincing. It is now definitely and strongly felt that this earlier conservative view was the sounder, that the later agreement with the idea of segregation was a hasty judgment and that the Sierra redwood should retain the name *Sequoia gigantea*.

Dayton⁴ has reported the results of a questionnaire sent to a number of Californian botanists and foresters asking for their views on this matter. It is clear that a large majority wish to retain the old name. The objections raised, in most cases, have not, apparently, a strictly scientific basis. They amount rather to the raising of a slogan "Hands off the Redwoods", or an appeal to the Save the Redwoods League. Is the Sequoia National Park to change its name? If there are in future to be no Sequoias in that happy Eden, must it now be called the Sequoiadendron National Park? Such an approach to this question may appear unscientific, nevertheless such objections have a force and a vivid claim to sympathetic consideration from all to whom a tree, and especially a redwood, is something more than a mere name in a catalogue. For these redwoods are not ordinary trees. They are among the world's wonders. They are the possession, not only of professional botanists, but of also every forester and of every tree-lover. It is easy to appreciate the feelings of so many, who, regarding them with reverence and awe, shrink from subjecting them to the cold pedantic analysis of scientific botanists. The point is that, from the replies to Dayton's questionnaire, there is shown to exist a strong human emotional background against which the naming of these trees must be viewed. The evidence forcing a change of name must, therefore, be very cogent, and it is the purpose of this short article to submit that there is no such cogency. On the contrary, even apart from this background, even if the Sequoias were little-known,

plants, familiar to only a few specialists, it is hoped to show that generic segregation, on the basis of the evidence advanced, would be, at least among the conifers, a case of unnecessary splitting.

It may be recalled that Looby and Doyle⁵, having emended Lawson's⁶ early account of development in *Sequoia sempervirens*, first showed that the proembryo in *Sequoia gigantea* differed from that in the coast redwood. Buchholz⁷ afterwards described differences between them in the early embryogeny and followed this shortly by his formal proposal¹ for a generic segregation. In a later paper Looby and Doyle² further described many differences in the earlier stages from gynospore to fertilization. This is the paper from which Jones³ has quoted, and in which a general agreement, now withdrawn, was expressed with the idea of segregation. It is at any rate clear, without delaying on specific illustrations, that, from gynospore to early embryo, there are many differences in development in the two species.

Now the segregation as proposed by Buchholz¹ is, in fact, formally based on certain external features, on six of which special emphasis is laid. But in this paper Buchholz lists also a series of differences between the two under thirty-three headings. Sixteen of these are gametophytic or embryological. Further, certain of the headings are emphasized in italics and each of these is claimed to be of generic significance. Of such items only six are external features, but ten are features of development. Clearly, although not included in the formal diagnoses, these developmental differences must have considerably influenced Buchholz in proposing the segregation. "These weigh heavily," he says, "in confirming the conclusion that we are concerned here with two distinct genera." I was certainly influenced at the time by these developmental differences, and by these alone.

A little further consideration, however, shows that the use of gametophytic and embryological features as points of generic significance cannot be readily accepted. Obviously such features can seldom, if ever, be employed in the discrimination of fossil genera and, to be of value among living forms, their application to the conifers as a whole must be considered—their significance cannot be limited to the Sequoias alone. If so applied, and if differences are significant, are similarities to be significant or are such features to be used or ignored at will? Thus, almost all the stages in development, from gynospore to early embryogeny, are similar in *Savagothaea* and *Podocarpus andinus*, some being all but indistinguishable even in detail. On the other hand, most stages in *Podocarpus andinus* differ from those in *Podocarpus nivalis*. Developmental phases in species of *Phyllocladus* and *Dacrydium* also resemble those in *Savagothaea* and all, at least up to the early post-fertilization stage, show some remarkable similarities with *Pinus* and *Araucaria* (cf. Looby and Doyle⁸). What is the generic significance of such facts as these? There are intergrades in living *Podocarpus* species, between the developmental type of *Podocarpus andinus* and that of *P. nivalis*, but, if *Podocarpus* to-day were only represented by two extreme types, what would the position be? It surely is that gametophytic and embryological features may be of great value in assessing broad relationships and developmental lines within groups, large or small, but their generic significance is doubtful and indefinite.

The differences in development which, in fact, exist between the two redwoods may be related to another feature listed but not emphasized by Buch-

^z Although the chromosome numbers have not been exactly counted, it is clear enough that *Sequoia gigantea* is a normal diploid conifer type with $n = 11$ or 12 , while *Sequoia sempervirens* is a raploid with $n = 22$ or 24 . Tetraploidy is rare in the conifers, being only known to occur elsewhere, according to Sax and Sax⁹, in one rather rare garden variety—*Pfitzeriana*—of *Juniperus chinensis* and probably also in *Pseudolarix*. There may be features in the genetic and chromosomal balance of the order unfavourable to tetraploidy. Certainly the constitution of *sempervirens* itself seems to be somewhat unstable, as shown, for example, by the great vegetative variability and by the extreme condition of seed abortion which occurs. Commercial samples, collected from natural habitats, may show only 3 per cent of good seed. A strong tendency to sterility appears also at the stages of gametophytic and embryological development, at least under Irish conditions, and considerable variations, amounting to abnormalities, occur frequently at certain phases. It is suggested, therefore, at the gametophytic and embryological features shown by the coast redwood are developments induced by the tetraploid condition and that the species is best considered as a somewhat sterile, unstable and slightly aberrant derivative from a basal ploid *Sequoia* type now represented by *S. gigantea*. It is unlikely in an angiospermic genus that a generic segregation would be proposed if a tetraploid species showed some peculiarities in development.

Since developmental features seem little suited for use as generic characters, segregation must be based on external features and, in fact, it is on such features that Buchholz¹ has been forced to make his formal distinction. There is, however, nothing new in the list of external differences drawn up by him. The features cited have long been familiar to systematists such as Torrey, Masters, and Pilger, and differences which failed to impress them cannot be blatantly different. Many of these differences are obviously of minor importance. A long list of such could be drawn up between any two species, the length of the list depending merely on the patience of the observer. Points such as variations in wood density, in habit, or in bark appearance can be readily paralleled in any large genus such as *Pinus*. It is not proposed to go over, *seriatim*, all the minor points listed by Buchholz. Reference here can be limited, and then as briefly as possible, to some of the features which he lists as of greatest generic significance and on which his distinction is essentially based.

(1) Buchholz emphasizes that the Sierra redwood requires two seasons to ripen the embryo and seed while the coast redwood requires only one. This, however, is merely another example of a widespread phenomenon in conifers. Forms closer to the basal type show frequently a longer cycle, derivatives and more advanced forms a shorter cycle, and this may be shown within the family or within the genus. Thus within the family Pinaceae *Pinus* retains a longer, while *Pseudotsuga* shows the shorter cycle, but within each of the genera, *Podocarpus*, *Dacrydium* and *Araucaria*, as examples, the same phenomenon occurs.

(2) Difference in form of the cone scales in the two species is emphasized. But the difference is, in fact, slight. It is much less than exists between many species of *Pinus*. It is a great deal less than exists between, say, *Athrotaxis selaginoides* and *A. cupressoides*. These, however, are linked by *A. lasifolia*, the scales of which are nicely intermediate between the other two. If this species did not exist, a stronger claim

could be made for the generic segregation of the first two on the basis of cone scale difference than can be made for the two *Sequoias*. It is of particular interest in this connexion to recall that Chandler¹⁰, in a revision of *Sequoites Couttsiae*, describes considerable variation in cone scale form. The same specimen may show thin imbricate scales, strongly peltate scales and many intergrades. Thus this well-known fossil type may show, in one specimen, greater differences in scale form than those which are claimed to be of generic importance in the living types. Further, even a small collection shows some variation in cone scale form in both the living redwoods. It is therefore worth while noting, in view of the great variability shown by *S. sempervirens* in its foliage, that it is not clear whether the slight difference in cone scale form is in fact constant over a wide range of types and habitat.

(3) The ovules and, later, the seeds are stated to be more numerous and in a double row in *S. gigantea*, but fewer and in a single row in *S. sempervirens*. But even Buchholz¹ himself states that this is not constant. He gives 3–7 as the ovule number in the latter species and 3–12 in the former. What then of forms with 5 or 6? A few minutes' dissection of young cones shows, in any event, that scales of *S. gigantea* with 5 or 6 ovules may show no doubling, while in scales of *S. sempervirens* with 6 or 7, some of the ovules are commonly out of place, forming an incomplete second row. Buchholz further gives the seed number as 2–5 in a single row for *S. sempervirens* and 3–9 in a double or single row for *S. gigantea*. It is difficult to see how a character which may show such wide variation and such a degree of overlapping can be used as a generic character.

(4) The foliage differences, including the leaf dimorphism of *S. sempervirens*, are emphasized. But it is surely common knowledge that much wider foliage differences are tolerated in other genera, *Podocarpus*, for example. If it be objected that the present *Podocarpus* should be split into a number of separate genera, must we then generically segregate *Araucaria Bidwillii* and *A. balansae*? The foliage difference between these is wider than that between the *Sequoias*. And what of the junipers? Buchholz refers to the foliage of *S. gigantea* as "juniperoid". It is not clear, however, what is meant by that term as there are to be seen, in *Juniperus*, flat linear leaves with an abrupt peg-like base recalling the spruces, similar leaves with a green decurrent base, smaller acicular leaves close to the stem, closely adpressed cupressoid leaves and a whole series of intermediate types—the extremes much wider apart than in the *Sequoias*.

In regard to leaf dimorphism, it is again common knowledge that many conifer genera include species with only one leaf form and species showing leaf dimorphism of various types. This is well shown by the podocarps and araucarians. Thus *Araucaria Bidwillii* shows dimorphism, but the foliage of *A. araucana* is practically uniform. *Podocarpus* and *Dacrydium* both include species with only taxoid or only cupressoid foliage and species showing varying degrees of dimorphism. Thus *Dacrydium Kareri* may carry, on the same branch, flat taxoid leaves up to $1\frac{1}{2}$ in long and densely imbricate cupressoid leaves averaging only $1/10$ in, and the transition is abrupt. Other species of *Dacrydium* are less spectacular, but these dimorphic types are not generically segregated on that basis, rather they help to link up the purely cupressoid and purely taxoid types. *Podocarpus dactyloides* also bears cupressoid and taxoid foliage,

the two types grading somewhat. The taxoid type is essentially juvenile, but considerable foliage mixture occurs on older branches. Specimens may, however, retain completely the taxoid foliage for periods up to a hundred years, dependent on habitat and environment, so that full-grown coning examples of the same species in the same locality may appear very different and at least as distinct as the two Sequoias.

The occurrence, in *S. sempervirens*, of branchlets of a giganteoid type and the fact that some specimens, especially on freely coning branches, may carry almost as much giganteoid as taxoid foliage suggest, then, that the leaf dimorphism can be considered a linking rather than a separating character. This is not the place to survey fully the vegetative features of the coast redwood, but one further comment may be made. Possibly in relation to a polyploid instability it is one of the most variable of conifers. No one specimen can possibly be selected as the type. It would need many herbarium sheets to illustrate the manifold variations which may quite commonly occur. It is then remarkable that Buchholz¹ lists as typical characters of generic importance features of the taxoid leaves which are not to be found in any living material here available and which are not recorded in any of the better-known descriptions and drawings. The leaves are said to be scythe-shaped and petioled with prominent midrib and revolute margins. If these features do occur on fresh material and were not described from dried specimens only, they cannot be characters of the type, but serve merely to extend the range of variability within the species.

(5) The buds of *S. sempervirens* are said to be scaly and those of *S. gigantea* naked. The meaning of the term 'scaly' is not quite clear, as it is obvious in winter that the dormant terminal apices of *S. sempervirens* are not covered with highly specialized bud-scales like a spruce or a fir. Anyone not familiar with the redwoods, however, could easily get the impression from this statement by Buchholz¹, and from others in the literature, that the 'buds' of *S. sempervirens* are rather specialized structures and quite different from those of *S. gigantea*, whereas, in fact, the basal structure of the apices of branchlets and twigs is essentially the same in both. As the commonly available accounts are rather inadequate, this point needs, unfortunately, more lengthy comment than the others.

A certain common plan of construction can be seen in many conifers—*Cryptomeria*, *Cunninghamia*, species of *Araucaria* and many others. Irrespective of the type of foliage, a number of the leaves at the end of a current twig in winter can be seen to be smaller, closely imbricate, and commonly of a modified and reduced form. The most terminal, which may be slightly more modified though grading into those behind, cluster closely round and protect the dormant apical meristem and the young leaves of the next season already organized by it. These outer protecting leaves themselves grade into the inner protected ones, the whole is thus a simple bud. We have here just a cessation of growth with protection given by the last-formed modified leaves of the previous year. On resumption of extension growth in spring the group of small terminal leaves is left behind as a special zone at the base of the elongating twig, and these zones, scattered along the branches, indicate the sites of the winter rest. Their distinctness depends on the relative size of the adult leaves. In *Araucaria Bidwillii* longer zones of linear pectinate leaves alternate with the shorter clustered zones, while in

Cryptomeria and many of the small-leaved species *Araucaria*, in view of the more compact foliage, the sites of the winter rest are less obvious or even or to be found by close scrutiny. In cupressoid form the distinction scarcely exists.

The Sequoias show a similar plan and similar differences. The contrast between the zones of linear pectinate leaves and short imbricated ones is commonly very obvious in *S. sempervirens*, whereas close scrutiny is needed to locate the sites of winter rest in *S. gigantea*. Incidentally, since the coast redwood shows such great vegetative variability there occur also, as might be expected, variations in bud organization. It would take a long descriptive account to explain adequately the nature of these and this is not the place to deal with them. Suffice it to say that such variations are slight or rare or main affect bud location. Typically, however, the structure of the terminal apices is essentially similar in both Sequoias and quite in accordance with the plan outlined above, so that it cannot be said that one shows scaly buds, in winter in the open, and the other does not. Of course, there may be differences, often marked differences (in detail), identical can scarcely be expected in two very distinct species. But often, as in the frequent case in *S. sempervirens* of short lateral branchlets closely covered with densely imbricate reduced leaves, the structure of the apex, as well as the appearance of the whole branchlet, may be so strikingly similar to corresponding branchlets of *S. gigantea* that careless scrutiny could confuse small detached specimens.

The coast redwood, however, shows the peculiarity which has probably earned for it the reputation of having 'scaly' buds. The terminal group of small modified leaves, left behind on the resumption of extension growth in spring, may gradually wither and become brown so that the base of each branchlet may be encircled with a cluster of thick brown leathery scales. A few points in connexion with these are of interest. The withering and browning, in the first place, are gradual—a matter of weeks or months. In the second place, though common, they are not necessary or constant. Examination of almost any specimen will show cases, often quite frequently, in which some or all of these modified terminal leaves remain permanently green. Further, the browning is not limited to the most terminal of these leaves, those that cluster immediately round the resting meristem and which might be considered bud scales proper. Those back along the stem, for a distance which is usually short, but which may extend to as much as an inch, turn brown also. It would appear that a certain number of the last-formed modified leaves of the previous growth, those fairly matured, exposed, and attached to a stem zone which will not elongate in spring, may turn brown. Those not matured in the previous growth, protected by the outer older ones, and attached to a stem zone which will show extension, expand as foliage leaves. Needless to say, the delimitation is not absolutely sharp and many intermediate stages may be seen in spring.

Thus it is not a question of one type having 'scaly' buds and the other 'naked' buds. In both we are dealing with similar buds of a simple construction and of a relatively common type. The point is merely that in *S. sempervirens* a number of the terminal modified leaves of the previous growth may or may not turn brown in the course of the succeeding season. This unstable feature scarcely seems sufficient weighty to necessitate a generic segregation, especial

within *Juniperus*, *Podocarpus* and *Dacrydium*, relation to their wide variation in foliage type, a much wider range of differences can be met with in structure and behaviour of branch apices. Any one with access to a collection of junipers, to take one case, will find species with well-organized buds protected by definite and distinct bud-scales which may be deciduous, species with a later browning, like that of *S. sempervirens*, species that behave like *Metasequoia* or *Araucaria Bidwillii*, species with only a slight difference in foliage around the sites of immaturity, species showing a cupressoid habit with a distinct break between successive years' growth, and many intergrades. If the intergrading species disappeared and if *Juniperus* was now represented only by *J. oxycedrus* and *J. virginiana*, these, on the basis of leaf habit and bud type, would have a greater claim to generic segregation than the two Sequoias. Unfortunately, however, the intergrades do exist. Clearly, one of the many phases of vegetative development shown in *Juniperus* is the organization of fairly specialized buds. To anticipate comment may be mentioned that some of the *S. sempervirens* variation types show a tendency in this direction, though this appears to be rare. Young shoots, however, arising after felling, show the simpler type of bud.

(6) Buchholz¹ also states, and considers it important, that in the coast redwood the cone matures, grows and sheds seed within the year, while, in the Sierra redwood, the cone remains, for a number of years, green, attached to the tree and retaining its seeds. Actually the difference between them is less than would appear from this statement, there is a difference of degree only and not of kind. In *S. sempervirens*, at least under Irish conditions, the cones begin obvious growth from the bud in November, the matured cones shedding their seed late in December of the following year or even not until January of the next year still. Thus from onset of growth to shedding of seed may take up to fifteen months, after which the cones remain attached to the tree for a further couple of years. In *S. gigantea* visible growth from the bud begins in March, and the cones open to shed the seed any time after the third succeeding December, full maturing being thus spread over from $\frac{3}{4}$ to about 4 years. During this period they gradually darken and harden. But at any time after the maturing of the seed, late in the second autumn of growth or example, cones, brought indoors and kept dry and warm (60° F or less), will open the scales and become brown within about ten days. Maturing cones of *S. sempervirens*, brought indoors about the same time while still dark green and closed, take, surprisingly, nearly as long to brown and open. The physiological difference between the two does not seem considerable. It would be of interest to relate the behaviour of the two redwoods to their very different ecological habitats and to determine, under natural conditions, the actual factors controlling the shedding of seed in relation to the age of the cone and the like. It is suggested, however, that the important point in the cone behaviour of the two species is probably the ecological one of the longer seed retention by *S. gigantea* and that the slowness of the changes in its cone advancing to maturity, changes which can be so hastened by drying, are physiologically related to this. Whatever its biological interest, however, the behaviour difference seems generically a minor point, comparable to the fact that, in many of the larger genera, the leaves may

persist on the stem for greatly varying periods. But even if the difference were more fundamental than it appears to be, the relatively longer retention of seed by *S. gigantea* is, in any case, paralleled elsewhere in the conifers and the point not given generic significance. Such a retention is well known to be characteristic of many species of *Pinus* and is also seen in species of *Cupressus*, *C. torulosa* shedding both seeds and cones at seed maturity while *C. macrocarpa* may retain the seed for years, its cones gradually darkening and hardening.

In addition to these comments on six of the features most heavily emphasized by Buchholz¹, a few words are necessary on a very important consideration not referred to by him. If this generic segregation be made between the two living types, what then is to be done with the fossil nomenclature? What meaning in future must be given to *Sequoiites*? Or must there be two fossil genera *Sequoiites* and *Sequoiadendronites*? And how are the known fossils to be sorted between the two? Take, for example, the well-known *Sequoiites Couttsiae*. Its foliage, using the criteria of Buchholz, would bar it from *Sequoiites*, and its cone, apparently, would bar it from *Sequoiadendronites*. Must we straight away found a new fossil genus for it? That way lies chaos. This again is scarcely the place for a survey of the relations between living and fossil Sequoias, but looking, without any special bias, at the fossil record as a whole, surely it is simplest, with our present knowledge, to take it as it appears to be, namely, the record of a widespread genus with a good range of form in foliage and cone, and it is surely simplest, for the present, to consider the two living redwoods as two surviving species, showing naturally certain marked differences, but differences within the gamut of the fossil range.

It is claimed, therefore, from this cursory survey, that against the background of intense human interest associated with the redwoods, there is no real evidence for a generic segregation. Ignoring the fossil record, as it does, the proposal appears based on the over-emphasis of points, long known to systematists and not of fundamental significance. The points of difference brought forward are either variable and intergrading or points which are definitely not given generic significance elsewhere in the conifers, even though shown in a more extreme condition. If the segregation of the two Sequoias is admitted on this evidence, such criteria must be applied to the conifers in general, and then a wholesale splitting of other genera must straightaway be made. Such splitting would affect, for a beginning at least, *Araucaria*, *Dacrydium*, *Juniperus*, *Podocarpus*, *Pinus* and possibly *Abies*. The logical issue might be, at the last, the institution of a separate genus for each species even reasonably distinct from its fellows.

Let us, then, leave those sentinels of the Sierras, the General Grant, the General Sherman, the Four Guardsmen, and the others, to stand watch in the centuries to come under a banner with the old familiar inscription—*Sequoia gigantea*

¹ Buchholz, J. T., *Amer. J. Bot.*, 26, 535 (1939)

² Looby, W. J., and Doyle, J., *Sci. Proc. Roy. Dub. Soc.*, 23, 35 (1942)

³ Jones, G. N., *Science*, 98, 406 (1943)

⁴ Dayton, W. A., *Leaflets West. Bot.*, 3, 209 (1943)

⁵ Looby, W. J., and Doyle, J., *Sci. Proc. Roy. Dub. Soc.*, 21, 457 (1937)

⁶ Lawson, A. A., *Ann. Bot.*, 18, 1 (1904)

⁷ Buchholz, J. T., *Amer. J. Bot.*, 26, 93 and 248 (1939)

⁸ Looby, W. J., and Doyle, J., *Sci. Proc. Roy. Dub. Soc.*, 22, 95 and 127 (1939), 23, 222 and 257 (1944)

⁹ Sax, K., and Sax, H. J., *J. Arn. Arb.*, 14, 356 (1933)

¹⁰ Chandler, M. E. J., *Ann. Bot.*, 36, 385 (1922)

GEOLOGY OF THE PUNJAB SALT RANGE

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MY first contribution to the discussions on the age of the Saline series or Salt marls in the Salt Range, both in the Punjab and in the trans-Indus area in Kohat, was published in 1928¹. Since then, several important papers on the subject have been published, by Messrs D N Wadia, L M Davies, G de P Cotter, E R Gee, and others. These have been very ably summarized by Dr W D West in a paper entitled "Some Recent Advances in Indian Geology. The Geology of Salt Range"². In the meanwhile, Mr E R Gee has completed his seven years careful and systematic mapping of the Punjab Salt Range and its continuation across the Indus into the North-West Frontier Province. He in 1939, finally arrived at the conclusion that the Saline series or Salt marls occupy a stratigraphical position below the marine Lower Palaeozoic strata and should be regarded as pre-Cambrian in age. Now quite recently Prof Burbal Sahní and his co-workers in palaeobotany at Lucknow have announced the discovery of abundant microfossils in the Salt marls³.

In the above-mentioned contribution Prof Sahní writes "Fossils found in the Saline Series in recent years have repeatedly suggested that the beds are early Tertiary or even younger. But the value of the evidence has been questioned. In view of these objections, I collected some lumps of rock-salt with intercalated thin laminae of saline earth or 'kallar' from positions deep within the salt mines, with the view of examining the kallar for possible microfossils. The investigation of this material has given results beyond all expectation: the bands of kallar must be teeming with signs of life, for every single piece has yielded microfossils. The great majority are undeterminable as to genus and species, being mainly shreds of angiosperm wood, but there are also gymnosperm tracheids with large round bordered pits, and at least one good, winged, six-legged insect with compound eyes. These facts suffice to prove that the Salt Marl of the Punjab cannot possibly be Cambrian or pre-Cambrian as suggested among others by Dr Murray Stuart, Sir Cyril Fox, and now also by Mr E R Gee, until recently a strong advocate for the Eocene view."

No one has, nor will, question the importance of these discoveries now recorded by Prof. Sahní—the presence of abundant microfossils in the kallar or red saline clay, which is found associated with the rock salt in the cis-Indus mines, but appears to be absent or rare in the trans-Indus exposures. It is quite another matter where the interpretation of these facts is concerned, because the meaning of the term *in situ* needs explanation in relation to original sedimentary deposition, as will be discussed later. Dr Sahní's communication conveys the impression that the microfossil assemblage is younger than Lower Tertiary (Eocene), the age which is usually ascribed to the Salt marl by those who have supported the idea that the Saline series is of Tertiary age. In view of Mr Gee's mapping and the Lower Palaeozoic to pre-Cambrian age which he has been obliged to admit, the question for the present must be how these Tertiary microfossils have found their way into beds which lie below those with a marine Cambrian fauna and are considered pre-Cambrian in age. It is to be

remembered also that Mr Middlemiss was so struck with the unaltered condition, both dynamically and chemically, of these Lower Palaeozoic formations the Punjab Salt Range that he compared them with the pages of a volume fresh from the binders' hands.

Mr Middlemiss' original remarks are well worth reading⁴. Although so old, the original sandstone shales and limestones remain as such and have not been converted into quartzites, slates or marble. It is the case with equivalent strata in the Himalayas. Nor are these beds in the Punjab Salt Range fourfold or even severely buckled in any widespread kind of way such as is common in regions of orographic mountains, as those in the trans-Indus area of the North-West Frontier. Beneath these unaltered Palaeozoic strata lie the plastic and soluble deposits of rock-salt and saline marl (kallar) of the Saline series, and above the Palaeozoic strata there are younger formations successively upwards to Lower and Middle and Upper Tertiary (see section given in Dr W D West's summary²). In the exposures seen along the scarp of the Punjab Salt Range the salt marl are the most disturbed where, as might be expected, such plastic material is able to escape outwards from under the weight of overlying strata and the overlying formations are seen to be tilted; though by block-faulting and, in places, have sunk into the marls (see ref 1, plate 9). In other places there are evidences of subsidence by the actual solution of the salt, as occurred in Khewra village in 1925, when it was found that a spring of water was removing salt in solution at the same rate as organized mining was producing salt for the Government of India.

At Pidh, on the Dandot plateau of Nummulitic limestones, the drainage is enclosed and sinks underground, and the water presumably carries some silt and such material in suspension with it. No details of the movements of such waters, or of the material they carry, have been made known, but there is very little doubt that such an investigation will yield interesting and perhaps surprising results both as regards the salinity of the water and the material carried in suspension at different stages of its journey. Indeed, it is quite well known that pieces of wood and even the trunk of a tree (of a type now found growing on the hill slopes) have sunk down so-called 'swallow-holes', and are met with embedded in the solid rock-salt as though by movements akin to regelation. The kallar itself was thought, by Dr W A K Christie, Dr Murray Stuart and myself, to represent the insoluble residue which is left when rock salt has been dissolved and removed in solution⁵. Indeed, it is not uncommon to see 'pipes', which are filled-up sink-hole channels, down which water came but which were later choked up with transported solid residue or saline red clay very similar to kallar.

So long ago as 1878, when writing the official opinion of the geology of the Saline series, which were then regarded as probably Infra-Silurian (in the Murchisonian sense that the Silurian included the Cambrian), Dr W T Blanford wrote as follows⁶:

"Owing to the softness of the marl, and to the tendency of harder rocks to slip upon it whenever it is sufficiently saturated with water, to destroy its coherence, and also to the salt beds being dissolved by water, the rocks of the Salt Range are broken and mixed up in a most complicated manner, masses of the marl having been squeezed by pressure in places into a position in which they appear to overlie more recent rocks, while all the newer formations are

cracked and faulted. The detailed geology of the range is consequently very intricate, and it is not always easy to tell whether dislocations of the strata are due to true faults traversing all the beds, inclusive of the salt marl, or whether the displacement is merely due to complicated landships."

Dr Blanford did not comment on the exceeding solubility of rock-salt (20,000 times that of limestone) or on the extreme plasticity of the saline marl, but these factors are thoroughly well known to-day, and will be appreciated by those who know the solvent effects of water on limestone—the various grottoes and caves, the removal of a bed of limestone beneath coal-bearing strata at Cherrapunji (Assam), the formation of bauxite (*terra rossa*) in the *dolinas* of Istria, etc.

Those who have a good knowledge of the probable depositional conditions—climates and land distribution—in the various geological epochs since Lower Palaeozoic era in the Indian region are well aware that an arid period almost certainly prevailed when the Upper Vindhya and their equivalents in the Salt Range—the Purple Sandstone—were laid down in early Cambrian or pre-Cambrian times, which, according to Mr Gee, and those of us who have held the same opinion previously, was soon after the rock-salt deposits had formed in the Punjab area. These desert conditions and marine associations were widespread at that early epoch of the historical geology of India and adjoining countries to the west, so that there is nothing improbable about the geographical aspects of a pre-Cambrian to Cambrian age for the Punjab rock-salt occurrences. On the other hand, there is little such evidence in support of an Eocene age for these deposits, and my own special studies of the coalfields of Baluchistan, the North-West Frontier Province, Kashmir, the Punjab and Rajputana can find no epoch when marine and climatic conditions could favour the deposition of salt on a considerable and widespread scale. Better possibilities may have existed in middle and upper Tertiary times, but so far as I know there has been no one who has claimed a younger age than Eocene for the rock-salt deposits of the Punjab or of the trans-Indus area. It is difficult to conceive of such conditions over the Salt Range area of the Punjab in middle Tertiary times and more so for such an upper Tertiary epoch, geographically at least.

The problem, therefore, seems to be to discover how the microfossils, found by Dr Sahni and his co-workers in the Punjab Salt Range, have been carried into the Salt Marl or Saline series which are regarded as Cambrian to pre-Cambrian in age. Also, and this is a similar problem, how it is that Messrs P. Evans and M. A. Majeed were able to show that the heavy mineral residues, from samples of the Salt Marl, agreed most with the results obtained from Tertiary strata. I have not seen these results and do not know with what Tertiary strata the Saline series would be correlated on this kind of evidence. I have had the reliability of the heavy mineral assemblages tested by obtaining samples of sand from the Damodar—in its upper waters, at several places on its course through the coalfields and finally where it enters the Burdwan alluvial plains—and found that the proportions of certain heavy minerals were remarkably persistent. This may thus suggest the idea that the streams flowing underground to the Salt Marl may have carried heavy minerals down with them with the same persistency of proportions prevailing as those in the rocks from which the water derived its heavy minerals. There may thus be no

evidence to prove that the Saline series are of the same age as the residues, from residues found in the rock-salt deposits. I suggest that the same argument applies to the microfossils. Incidentally, full details are not yet available of these microfossils, and a great deal more has to be done, such as a search for similar remains in the Tertiary strata of the Salt Range.

A small field committee consisting of Dr H. Crookshank and Mr E. R. Gee of the Geological Survey of India, with Dr E. Lehner and also Messrs E. S. Pinfold and J. Coates, geologists of the chief oil companies in India, are, at the time of writing (November 7, 1944), in the Salt Range to re-examine all the critical geological sections. They will no doubt give the subject of Dr Sahni's microfossils and Mr Evans's heavy mineral assemblages the most careful consideration [see p. 266 of this issue of *Nature* Eds.] They are also unlikely to leave the question of the gypsum unattended to, but in this connexion I would say that the conversion of limestone into gypsum is not a remarkable phenomenon if the necessary conditions are favourable and a decomposable sulphide, such as pyrite, is available. The gypsum is, of course, a secondary product whatever might have been the age of the original materials involved—limestone and pyritiferous coal as an example. It is very likely, indeed to be expected, that a careful examination of the gypsum for microfossils and heavy minerals would provide evidence as to the age of the original substance, for example, limestone. It does not follow that this method of determination will fix the age of the strata in which the gypsum occurs, because the limestone (if so proved) might have been xenolithic. For example, it may be in other strata than those belonging to the beds in which the limestone was deposited and in which it was originally truly *in situ*.

In contrast with the absence of tectonic folding in the strata above the Salt Marl in the Punjab Salt Range, as around Khewra and Dandot, the beds associated with the rock-salt in the trans-Indus areas are characterized by folding. Highly inclined beds with evidences of synclinal and anticlinal structures are common. Indeed the rock-salt occurrences appear to be normally found in faulted anticlinals in this Kohat region. It is just the position in which a plastic substance might be expected if it had been squeezed up from below by the dynamic forces of folding. The salt certainly appears to have been extruded upwards by great tectonic pressure, and shows evidence of this in its own texture. From a distance of only a few yards the rock-salt can often be mistaken for gneiss, as it possesses a gneissose structure, but is thus entirely different from the rock-salt in the Punjab, which appears to have escaped this degree of dynamic force. This is in general agreement with other observations. The trans-Indus region is closely involved in the orographic mountain ranges of the Indian borderland, while the Punjab Salt Range can scarcely be claimed to possess any orographic axis and is largely the southern scarp of a plateau region. It is for this reason that the supporters of a Tertiary age for the Salt marls have usually invoked an almost flat plane of sliding for the superincumbent strata. It is needless to say that over-thrusting for twenty miles or so in a region evidently devoid of serious folding has always been a mechanical defect in such explanations.

It must therefore be recognized that the two regions—the *cis*- and the *trans*-Indus—are orographically different, although one passes almost insensibly into the other. For this reason the rock-salt

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has behaved differently under tectonic squeeze—which was very severe in the trans-Indus area and almost absent in the Punjab area. The salt deposits are probably of the same age—laid down in Cambrian and pre-Cambrian times. They were protected by overlying strata until comparatively recent times, when erosion in the Punjab area and dynamic folding in the Kohat region have disclosed these valuable deposits, which have been preserved for us since the Lower Palaeozoic age. The treatment of the plastic salt in the folded strata will fully explain how it escaped upwards along a fault into an anticlinal, also how it was carried upwards or became entangled with newer strata—nummulitic limestone, oil shale or pyritiferous coal, and further, how when conditions and material were favourably disposed, gypsum has formed—from the included or xenolithic fragments in the rock-salt or adjacent to it in the strata from which the xenoliths were derived. The *modus operandi* in the Punjab area was somewhat different, it consisted of subsidence by solution and transport by underground water, whereby blocks of stone, tree stems and other derived material (such as microfossils and heavy minerals) have become embedded in the salt and in its insoluble residue (the kallar) in the Saline series of the Punjab areas. In neither case, however, *cis-* or *trans-*Indus, are these incorporated materials strictly *in situ*, and thus any gypsum formed from such derived material is, so to speak, truly *tertiary*, but in a *primary* setting.

In conclusion, I would like to quote a few lines from the last report submitted to the Government of India by Mr. H. B. Medlicott, director of the Geological Survey of India, before he retired in 1886⁷. He wrote:

"The geologist's work is therefore sound and useful or false and misleading in proportion to his real acquaintance with the actuals and the principles of the exact sciences, and unless he reaches a certain standard of excellence his work is absolutely useless, or worse. In this respect the geologist is unique. A doctor may acquire a useful skill in the practice of medicine without being anything of a biologist; an engineer may do fair work with little or no knowledge of mechanics, a man may be a surveyor without any proper knowledge of geodesy or astronomy because in all these businesses there are practical rules by which ordinary work can be safely executed. Geology is the opposite of all this: there is no operation called for every act in its service is an independent judgment upon very complex inductive facts through an accurate knowledge of physical phenomena and their laws, if not scientific it is nonsense. Further it is to be noted that the data upon which the geologist has to frame his judgments are for the most part very scanty from occasional scattered sections or single outcrops he has to attempt the representation of the rocks as they lie underground and their remote history. Thus, though based on the exact, it is itself the most inexact of sciences, and eminently demands conscientious and sober judgment. There is no science with which it is so easy to acquire a superficial acquaintance and to play the impostor."

¹ See *Rec. Geol. Surv. India*, 61, Pt. 2 (1928), pp. 147-179, with plates 2-17 showing various views of plastic marls, tilted strata and subsidences.

² *Current Sci.*, 3, No. 9 (March 1935).

³ *Nature*, 153, 462 (1944).

⁴ *Rec. Geol. Surv. India*, 24, 19 (1891).

⁵ *Rec. Geol. Surv. India*, 44 (1914), 50 (1919).

⁶ "Manual of the Geology of India", Pt. 2, Extra-Peninsular Area, p. 487 (1878).

⁷ *Rec. Geol. Surv. India*, 20 (1887), Annual Report for 1886, p. II.

THE most striking characteristic of the open conference on "Science in Peace", organized by the Association of Scientific Workers at Caxton Hall, Westminster, on February 17 and 18, was neatly expressed by Prof. J. D. Bernal in his final summing-up of the Conference. The content of the fifteen papers submitted in three sessions devoted respectively to "Science and Production" (chairman, Prof. P. M. S. Blackett), "The Future Development of Science" (chairman, Sir Robert Watson-Watt) and "Science in Everyday Life" (chairman, Prof. H. Levy) had, he said, had the quite remarkable quality of having been 'orchestrated'. An account of the whole opus will accordingly be attempted here, not by separate discussion of the component movements, but by tracing the *leit-motiv* which recurred so clearly, inevitably and appropriately through all. They are all familiar themes enough, but their interrelations took new emphasis, and their combined intellectual and emotional appeal was profound. They were expansion, investigation, documentation, publication (the key theme in some expected and some less expected contexts), organization, integration, mechanization, standardization, nationalization.

The Conference opened appropriately with a paper on "The Future of British Economy", by G. D. N. Worswick, and closed equally appropriately with one on "The Place of Science in Culture", by Prof. B. Farrington. The whole argument of the Conference was necessarily based on an expansionist economy providing full employment, the practicability of continuous full employment is in large measure governed by the full utilization of science, including the scientific control of processes, on the other hand, potentially revolutionary applications of science in industry are only acceptable to the workers if their justifiable fears about continuity of employment are categorically answered by a declared Government policy for assured and continuous full employment. The honouring of such an assurance depends on giving to the public interest its rightful place relative to private interest, and this in turn can only be assured by a substantial measure of Government control. No point made was more heartily applauded than the statement that bureaucracy is far more prominent and harmful in the larger aggregations of 'private' enterprise than in Government departments. Government control, varied and adapted to the needs of public interest in application to each main industry, must be control by the people acting through a democratic government in the interests of the people. The overall success of government control in the greatly expanded industry of the war effort was cited as an augury for the future.

The paper by Mr. Joe Scott, member of the Executive Committee of the Amalgamated Engineering Union, on "Science and the Productivity of Labour", emphasized the role of science in improving the conditions of life of the worker while at work and at leisure, in lightening labour and improving the use of leisure in avoidance of injury and improvement of health. He stressed the inseparability of science from production, it was another of the recurrent themes of the Conference that we are no longer dealing with separable applications of science to industry, that we are now at a stage where scientific method should be inherent in every step of the industrial process, where the permeation of science through the whole of industry is a happily

irreversible process preventing the picking out of amplexes to be exhibited as 'science in industry'. This permeation of process demands a corresponding permeation of organization, in which the place of scientific work in the national economy is recognized and insured by detailed interlacing in an industrial democracy, at all levels and in all significant groupings. An important element in this permeation is a much closer co-working with the trade unions, individually and collectively.

Mr Scott introduced the two themes of investigation and documentation, with examples of welfare and health investigations, which could not have been carried through save by the machinery of the trade unions and shop stewards, and, from another angle, with a plea for direct availability to trade union negotiators of the scientific and technical facts which they require to support and answer statements made in negotiation.

This was one aspect of a universal demand for public availability of the facts—many already known privately, many not yet known even to managements in private enterprise—by which the efficiency and potential of any stage in the industrial process can be measured. The filling of the gaps in private and public information is essential to progress, and involves the large application of the methods of operational research within industries. There is need, indeed, not merely for organized research but also for research on organization, the appropriate structures for scientifically operated and publicly controlled industry are still in large measure unknown or ill-understood.

The demand for publication as a safeguard of the public interest was pressed at every session and thus in many different connexions. If it were necessary or desirable to condense in four words the essence of the discussion on "Science in Everyday Life", the words might well be "Publish and be Blessed". Full and free interchange of knowledge not only from scientific research, but also from studies on organization, not only on engineering efficiencies but also on economic efficiencies, 'all facts on the table' was regarded as essential to increased productivity, to improved conditions of life, and to the avoidance of diversions in favour of private interests.

"The Organisation and Finance of Science" were discussed by Dr S Lilley, who argued the case for the Association of Scientific Workers policy in favour of a national research and development council, responsible to the Lord President of the Council, for surveying national needs and resources and planning the broad lines of scientific work to meet the needs and develop the resources. The Council would plan the strategy of attack on these problems, it would neither execute the work in laboratories of its own nor interfere in the tactics of work in the laboratories, of existing types, to which it would allocate broad responsibilities and adequate finance. Expenditure at the rate of some twenty-four million pounds per annum, as compared with our pre-war seven million pounds per annum, it was stated, is required, a great expansion of laboratories would be needed, the research associations would be key factors in the plan, and no industry would be allowed to stifle co-operation by the withholding of financial contributions, the naive form of subsidy-without-supervision represented by tax remission on alleged research should not be permitted, publication of results would be insisted on. The new organization would require the participation of the representatives of the

people in general, and of the scientific worker in particular, at all levels in the formation and execution of policy.

An important part of the problem of the deployment of our scientific forces is the striking of a balance between long-term fundamental work and short-term work of direct and immediate application. The chairman of the session on "The Future Development of Science" described the problem as one in the "intellectual economics of the social conscience", Prof Blackett emphasized the high long-term productivity of fundamental science, which must pass from its old state of self-determination towards an imposed orientation arising from increased direct support from public funds. This fundamental science must be guided by men of science, acting under broad directives on social objectives coming not from a bureaucratic Civil Service but from public opinion through Parliament and the Government answering to Parliament. An important part of this direction must rest on the economic policy adopted by the nation, there is virtually no limit to what science can do, there are limits set by economics on what it is worth doing, for example, in developing synthetics and substitutes as an alternative to importing. A short-term crisis, such as the present War, is the only exception to the law which forbids the sacrifice of the big future dividends offered by fundamental research to the smaller quick returns of too closely applied development.

Both Sir Robert Watson-Watt and Prof Blackett directed attention to the need for a federation which could speak with the voice of the scientific practitioner at large, on a wider basis than the highly selective Royal Society and the highly specialized professional institutions, including the Association of Scientific Workers, with its vitally important trade union affiliation, but not excluding those who do not recognize that affiliation as necessary or desirable.

Prof Bernal, in his contribution on the future development of "Applied Science and Technology", carried the development of the theme of 'organization' into the enunciation of the theme of 'integration'. The application of science is the practical side of the war against poverty and calls for the same spirit and intensity of organization as the current War. The revolution in the relations of science to industry is now far advanced, the essential now is the complete integration of science with industry, the dual problem is to make industry scientific through and through, and to make this possible by demonstrating to the public the need for this permeation and integration. The public has still far to go in appreciation of the need: it is still merely 'gadget-minded'.

This integration demands the full democratization of science in industry, democratization is far less advanced in industry than in politics. One necessary element, that of public criticism, is provided in the political sphere by Parliament, it could be provided in the sphere of industrial science by trade union organization. Only the scientific worker can determine the mode of application of science in industry, for this he must sit in the board room of management for the formation of policy, he must equally find his place in the joint production committee.

Integration, as was shown in those contributions to the first session which dealt with the basic industries of Britain, must be carried over the whole area of each industry and across the frontiers between industries, the separation of the generation of gas

from the generation of electric power and of both from the full utilization of coal is as artificial, irrational and wasteful as is the treatment of the coal industry as something apart from the chemical industry, of which coal is the very foundation

Discussion on the coal industry was the most important single development of the mechanization theme, and it led to the conclusion, not from any devotion to nationalization as a good-in-itself, but from lessons in the long unhappy history of that industry in particular, that mechanization in coal-getting would not be attained without governmental control so firm and detailed as to mean nationalization. The applicability of any such simple prescription as 'American machinery everywhere' was recognized, but there was a clear conviction that a plan of mechanization measured to the geology and the degree of past working is of extreme importance.

The discussions, which brought in variations on the theme of mechanization, interwove it so intimately with the theme of standardization that an answer to criticisms of 'dullness through standardization' was specially important. It was pointed out that general availability of the products of industry depends on the wide extension of mechanization, that mechanization can only be reasonably effective if the production runs are long runs giving large numbers of one pattern, and that consequently the total number of patterns available to the total field of consumption would be reduced. This does not, however, mean that the average consumer, with limited purchasing power, has a reduced range of available patterns. He would, in fact, have access to a wider range of better models, brought within his reach by the economies in cost attained through mechanization.

The Conference was made notable by the resumption of personal international contacts on a scale only now becoming possible as the war situation improves. The Sunday morning session was marked by the enthusiastic reception of addresses by Dr Marcel Matthieu, a member of the executive committee of the French Association of Scientific Workers, and

by Prof. A. Danilov, chairman of the U.S.S.R. trade union covering scientific and ancillary workers in the laboratories of the universities, the academies of science and the research institutes. Prof. Danilov was accompanied by four other Soviet colleagues. It was noteworthy that the Soviet delegation to the World Trade Union Congress meeting in London included three scientific workers.

The Conference adopted at its closing session a resolution in the following terms:

"This public conference which has met to consider the tasks of science after the war, records its whole-hearted admiration of the fighting forces of the United Nations whose great achievements are bringing peace nearer at hand. Their deeds are providing the foundations for a better world while the advance of science and technique are the tools with which it can be built. This conference declares its conviction that

(1) The achievement of a progressive rise in the standard of living of mankind needs the fullest use of science and technique within the framework of a world expansionist economy

(2) An expansionist economy policy at home implies assistance to the backward and undeveloped countries to raise their productive level by the establishment of modern industry and scientific agriculture

(3) In this country the advanced and efficient application of science requires democratic planning largely by scientists themselves. For this we propose a central research and development council under the authority of the Lord President of the Council

(4) The problems facing the manual workers in the future, arising from the effect on their working conditions, of scientific and technical advances, demand close collaboration between the organized scientists and the rest of the Trade Union movement

(5) The closest collaboration must be achieved between the people of all nations, including the fullest interchange of scientific and technical knowledge based on the contacts now being built between the scientists in Great Britain and the Dominions, the U.S.S.R., France and the U.S.A."

NEWS and VIEWS

Chemical Engineering at Cambridge

THE period extending between the two World Wars has been remarkable for the advances made in what is usually termed 'technology', and it is especially in chemical technology that this development has been most rapid and spectacular. A scientific discovery in a chemical research laboratory may be the progenitor of a finished manufactured article, but the aims and objects of the discoverer and those of the manufacturer are quite different. Since the manufacturer is interested in producing an effect, and since also economics plays an important part in his considerations, it is clear that many steps alien to a pure research laboratory have to be taken after a discovery has been made before a plant is in actual operation. We are confronted with the problem as to the most suitable training for such workers in chemical technology. Prof. Haber, who was at Cambridge at the end of the War of 1914-18, when asked what English chemical industry needed, replied that our weakness lay in not applying the methods of physical chemistry to industry. There is more than a germ of truth in

this. Chemical engineering may be regarded by some as a misnomer for chemical technology, and it is within the orbit of physics and chemistry rather than engineering that the new development should take place.

The larger industries in Britain can train their own men, but this is impossible in smaller units. The training given in the Technische Hochschulen on the Continent, or the Massachusetts Institute of Technology in the United States, has proved eminently successful in the respective countries. In Great Britain it appears that such further development as is required will take place in the universities. Hence the munificent gift of about half a million pounds by the Shell Group of oil companies to the University of Cambridge for the endowment of chemical engineering comes at an appropriate time. The University, in accepting this, has likewise incurred a great responsibility. It is generally recognized that we have much leeway to make up to survive in the post-war world as an industrial nation. The chemical industries of Britain are by no means

the least important contributors to the country's wealth and may well become a dominant factor. Increased burdens will be placed on the nation's chemists and chemical engineers, and their training must be such that they can achieve the tasks that lie ahead. Care must be taken that the new Department is continually nourished by its roots—the subjects of chemistry, physics, mathematics and engineering, and those who pass through it should then build on sure foundations.

U.S. Research Board for National Security

ESTABLISHMENT of the Research Board for National Security by the U.S. National Academy of Sciences was announced on February 11 by Mr. Henry L. Stimson, U.S. Secretary of War, Mr. James Forrestal, U.S. Secretary of the Navy, and Dr. Frank B. Rowlett, president of the National Academy of Sciences. The Executive Committee of the new Board will be headed, by Dr. Karl T. Compton, president of the Massachusetts Institute of Technology, and the Board will consist of seventeen civilian men of science and nine representatives each from the army and navy, including Major-General Norman T. Kirk, Army Surgeon-General, and Vice-Admiral Ross T. McIntire, chief of the U.S. Navy Bureau of Medicine and Surgery. Civilian members include Mr. Herbert S. Gasser, director of the Rockefeller Institute for Medical Research, Prof. E. O. Lawrence, professor of physics at the University of California in Berkeley, and Prof. Isador I. Rabi, professor of physics at Columbia University. The Secretaries of War and Navy requested the president of the National Academy of Sciences under its congressional charter to establish the Board "to assist in providing for continued civilian participation in the longer-term scientific problems of national security when the Office of Scientific Research and Development proceeds to liquidate its activities as a temporary war-time agency. . . . The objective of the Board will be to continue, pending final consideration by Congress on creation of an independent agency, the close co-operation between civilian scientists and the armed services which has proven to be such a vital element in the prosecution of the war. Composed of high-ranking officers responsible for the needs and plans of the Army and Navy with an equal number of distinguished representatives of science, engineering, medicine and industry, this Board includes many of the features of the Office of Scientific Research and Development which has proven so successful as a war-time agency in mobilising civilian scientists and co-ordinating their work with the requirements and operations of the armed services. . . ." The announcement pointed out that "science is here broadly interpreted to include the employment of scientific method of analysis, experiments and tests in any branch of science or technology including engineering, medicine, psychology and biology."

Science and Planning

IN a memorandum "Science and the Real Freedoms" issued by the Association of Scientific Workers (price 3d), Sir Robert Watson-Watt gives a very fair appraisal, under the title "Freedoms of Science", of the issue between planning and freedom, successfully avoiding the political prejudices with which the discussion is apt to become entangled. Sir Robert's article is based on a speech delivered in Manchester last October. He insists first on the necessity for clearly defining our terms. Science he regards as

organized knowledge, but he considers that those constructive pursuits requiring for their prosecution, expansion and usefulness the application of a like process of thought are also properly covered by the term 'scientific'. The pure and applied sciences are in fact planned sciences. There is no human activity which is not a planned activity, and Sir Robert urged that we should consider whether organization in hope is not a nobler and more fruitful aspect of human endeavour than the organization of and through fear which has inspired our planning for war and even extended to the medical sciences. Asserting that the freedom to learn, to choose, to think, to work and to speak are the fundamental freedoms of the individual and the pillars of any tolerable society, Sir Robert urged that the real question is whether planning—which is inevitable—is to be open and public, or sectional, secret or selfish. He visualizes a structure in which the user who wants a definite result asks the research worker, the developer and the producer how best, by what particular kind of planning, he can attain his result, the research worker, the developer and the producer co-operate with the user, indicating to him the full possibilities. The greatest danger is over-simplification, but the planning of science in the application to national life is possible with no substantial risk to the freedom of fundamental science.

Education and Training for Engineers

IN a second report now issued by the Institution of Electrical Engineers, it is suggested that provision should be made for the education of craftsmen, technicians and professional engineers. There should be a three-year course for a craftsman certificate, followed by a more general course, lasting two years, in workshop administration. For the technicians group, the existing course for the ordinary national certificate in electrical and mechanical engineering should be co-ordinated as a basic course, and this should be followed, where necessary, by a course in advanced technology. Students who do well in the first two years of the ordinary certificate course should be combined with those who have reached the standard of a good school certificate in mathematics and physics, and these students should enter a two-year course leading to an intermediate national certificate designed to meet the requirements of the Section A examinations of the Institutions of Civil, Mechanical and Electrical Engineers. These courses would lead to the higher national certificates in electrical engineering and kindred subjects. Another section of the report contains proposals for the further education and training of electrical engineers returning from the Services.

University of Birmingham

THE Court of Governors of the University of Birmingham has nominated Mr. Anthony Eden for appointment as Chancellor of the University in succession to Lord Robert Cecil. The Pro-Chancellor (Mr. E. P. Beale) has announced that a public appeal for £1,000,000 will shortly be made to enable the University to proceed with urgently needed developments, especially the bringing together on one site of all the departments (some of which still remain in the centre of the city) and the building of additional halls of residence. Many of the donors to the appeal for £250,000 for rebuilding and re-equipping the Departments of Mechanical and Electrical Engineering have expressed the opinion that a great need of

the provincial universities is a fuller communal life for the students, such as can be secured by halls of residence

Electric Discharge Lamps for Photography

MR H. K. BOURNE presented a paper on this subject, illustrated by a comprehensive display of typical lamps, at a meeting of the Association for Scientific Photography on January 27. Photographically, electric discharge lamps have high actinic efficiency combined with low heating power, and they have a long life. Since the early days of the Cooper-Hewitt lamp, a glass tube several feet in length with a mercury pool at the end, development has proceeded along two divergent lines, low pressure and high pressure. In the modern low-pressure lamp, the pressure of mercury vapour is only a fraction of a millimetre, it emits considerable long- and short-wave ultra-violet radiation, which by means of fluorescent powders on the inside of the tube is converted to visible light of longer wave-lengths. It provides a well-diffused light-source closely resembling daylight and capable of giving accurate colour rendering. The high-pressure mercury vapour lamp consists of an inner glass tube containing the arc, sealed into an outer glass jacket. The arc tube pressure is about 1 atmosphere, and the arc is constricted into a narrow cord along the axis of the tube. The outer envelope is filled with an inert atmosphere. There is a wide range of types, the most powerful being in powers of the order of 10 kW or higher, with a brightness ranging up to 100,000 candles per sq. cm. The spectrum is linear in character, and fluorescent powders cannot be used with the high brightness lamps, but with increasing pressure there is an improvement in the colour, the main lines broadening while the amount of continuous background increases. An amalgam of cadmium is sometimes used to improve colour. Brightness increases with increases of loading per unit length in the arc column, which has been made possible, first by the use of quartz tubes with molybdenum foil vacuum-tight seals, and later by the introduction of water-cooling, which dissipates approximately 70 per cent of the radiated heat. The author described a number of lamps including a compact source lamp with a maximum brightness of 18,000 c/sq. cm., a self-contained metal box-lamp which can be used without a lamphouse for the illumination of laboratory instruments, a 100-hour-life water-cooled high-pressure lamp with a luminous efficiency of 65 lumens per watt, a peak brightness of 30,000 c/sq. cm. and an internal pressure of about 75 atmospheres, and the B.T.H. syroscopic tube which can give recurring flashes at a predetermined frequency or be employed as a synchronized flash-lamp for ordinary photography.

Resources of Ireland

IN celebration of the centenary of the publication of Sir Robert Kane's "Industrial Resources of Ireland", the Royal Dublin Society has published (price 2s. 6d.) a number of lectures delivered before the Society last August, under the general title of "The Natural Resources of Ireland". Prof. M. A. Hogan, in reviewing the fuel resources of the country, does not see much hope of increased coal production, but believes that resources of the limited coalfields are sufficient to last at least 250 years. He foresees, on the other hand, a great increase in the use of turf, provided that mechanized means of cutting it can be devised. This would entail the preliminary easy drainage of

large areas of bog, in order to bear the weight of heavy cutting machines. Mr. J. A. O'Riordan discusses the possibilities of water power. The Shannon and Liffey schemes have made a notable beginning, and their theoretical capacity is estimated at 84,000 horse-power. Gauging stations on other rivers and possibilities, still unmeasured, of smaller streams promise great accretion to these resources. Mr. O'Riordan thinks that the potential production of hydro-electric power could eventually be doubled. It is to her water-power resources that Ireland must clearly look for energy in the future. A review of the mineral resources other than fuel, by Mr. D. W. Bishop, shows little of importance except phosphates. The metallic mineral resources are very small. Some ores, in small supply, seem to have been exhausted.

Studies on Pollen Analysis

THE study of pollen has come much to the fore during recent years. The pollen analysis of peat has become one of the most important techniques used in the study of post-glacial vegetation. Partly in view of the necessity of studying such geological data in terms of processes now in operation and partly in order to obtain information relating to plant allergens research is now being directed toward fundamental problems relating to the liberation, dispersal and deposition of air-borne pollen. The results will have obvious implications in the field of floral biology and should also be of value to the meteorologist. The pollen of insect flowers is receiving attention as a means of determining the source of samples of honey. All the above studies have, up to the present, been referred to under the general heading of pollen analysis. The need for a better name has been expressed in *Pollen Analysis Circular*, a cyclostyled research bulletin edited by Prof. Paul B. Sears, of Oberlin College, Ohio. Messrs. H. A. Hyde and D. A. Williams, of the National Museum of Wales and Llandough Hospital, Cardiff, respectively, in the October issue of that *Circular* suggest the term *palynology* (Gk. *παλύνω* (*paluno*), to strew or sprinkle, cf. *πάλη* (*palē*), fine meal, cognate with Latin *pollen*, flour, dust) for the study of pollen and other spores and their dispersal, and applications thereof. It is hoped that the sequence of consonants p-l-n (suggesting pollen, but with a difference) and the general euphony of the new word will commend it.

Motor Control-Gear

A PAPER read recently in London by D. Rudd before the Institution of Electrical Engineers reviews, in general terms, present-day practice in the design of industrial motor control-gear. The scope of the paper is limited to standard industrial equipment and the subject is approached from the user point of view. The first part reviews the principles on which modern design has been established, and the later sections discuss some of the factors that are likely to affect future development. The author states the case for the utmost simplicity in design and for greater latitude in the value of allowable starting-current peaks. Possible development in contact materials is discussed, and reference is made to the possibility of achieving some measure of standardization.

Veterinary Medical Institute

ACCORDING to the December issue of the *Anglo-Swedish Review* a new veterinary-medical institute has recently been inaugurated in the northern out-

karts of Stockholm One of the largest and most important departments is that for the production of horse serum The stables with boxes for about eighty horses have been built with slanting lantern-roofs which let in the light above the boxes, and every box is provided with running water Each of the horses produces about seven litres of blood, or raw serum, a week Hot and cold air is supplied according to the season In another and equally well-kept section are quarters for a large number of calves The Institute comprises three sections: a pathological, a bacteriological and a serological section, which are supplemented by a mechanical and a parasitic laboratory Altogether about 150 persons are employed The new Institute provides increased facilities for effective combating of diseases of domestic animals, which still cause heavy losses.

American Birth-rate

ACCORDING to statistics of the Metropolitan Life Insurance Company (*J Roy Inst Pub Health and Hyg*, Jan 1945), young mothers between the ages of twenty and thirty having their first child have been the principal contributors to the rapid war-time rise in the American birth-rate The chief factor in the rise at these younger ages has been the increase in the marriage-rate, but a good part of the rise has been accounted for by women who had delayed having children until economic conditions were more favourable Although the general birth-rate increased rapidly during the war period, the trend towards small American families as well is still in evidence, and families with five or more children continue to decrease

Bright Light Sources

A PAPER read by J N Aldington on November 14 last before the Illuminating Engineering Society gave a general survey of tungsten filament projector lamps, showing the trend of recent developments in this field The paper embraces consideration of the characteristics of tungsten filaments *in vacuo* and in gas-lamps employing both single-wound and double-wound helices, multi-filament lamps, and symmetrical light sources Various types of lamps are illustrated photographically, and lamp performance data are given in tabular form

Dried Starfish as Chicken Meal

IT is reported (*J Amer Vet Med Assoc*, 55, 151, 1944) that starfish, collected in the process of cleaning oyster beds, are now being dried and ground up to make chicken meal An analysis of the meal showed that it contained 30.7 per cent protein, 17.6 per cent calcium and 0.35 per cent phosphorus Tested against sardine fish meal of equal protein value, it proved its value as food, but its use had to be limited to 3.5-5 per cent of the total ration, because of the high proportion of calcium

University of London

THE title of 'professor emeritus' in the University of London has been conferred on the following: Prof. R H A Plimmer, who held the chair of chemistry at St Thomas's Hospital Medical School during 1922-42, Sir Owen Richardson, who held the Wheatstone chair of physics at King's College during 1914-24 and the Yarrow Research professorship of the Royal Society attached to King's College during 1924-44, Dame Helen Gwynne-Vaughan, who held the chair of botany at Birkbeck College from 1921

until her retirement in 1944 and was a member of the Senate as a representative of the Faculty of Science during 1929-34, Prof. Eva G R Taylor, who held the chair of geography at Birkbeck College from 1930 until her retirement in 1944

Dr C W Shoppee has been appointed to the University readership in chemistry tenable at the Royal Cancer Hospital (Free) Since 1939 he has been working at the Pharmaceutical Institute in the University of Basle

The title of professor of mathematics in the University has been conferred on Dr Paul Dienes, in respect of the post held by him at Birkbeck College.

Announcements

THE Medical Research Council has appointed Prof. A A Miles, professor of bacteriology at University College Hospital Medical School, London, to the staff at the National Institute for Medical Research as from October 1, 1945, with the view of his becoming director of the Department of Biological Standards on the retirement of Sir Percival Hartley next year

PROF. F Y HENDERSON, reader in timber technology in the University of London and assistant professor in timber technology in the Imperial College of Science and Technology, has been appointed director of Forest Products Research in the Department of Scientific and Industrial Research on the forthcoming retirement of Mr W A. Robertson, who has been director since 1933

MR V M WADSWORTH has been appointed assistant lecturer in agricultural economics in the University of Leeds

M TURGUT EREM, the first educational attaché to be appointed to the Turkish Embassy in Great Britain, has arrived in London, he will act as inspector of Turkish students in Britain, of whom there are now about a hundred, including eighteen holders of scholarships awarded by the British Council, with which M. Erem will be in close touch

THE Institution of Civil Engineers, with the Institution of Municipal and County Engineers, have appointed a joint committee to draw up notes for the use of engineers on the best location of underground services The Committee will consist of Mr W H Morgan, county engineer of Middlesex, as chairman, and ten other members, representatives of electricity and gas supplies and post office services have been nominated by or in consultation with the Institution of Electrical Engineers, the Institution of Gas Engineers and the chief engineer, G.P.O. respectively Communications should be addressed to the Secretary, Joint Committee, c/o Secretary, Institution of Civil Engineers, Great George Street, Westminster, London, S.W.1

THE following appointments have been made in the Colonial Service: C F Charter, to be soil chemist, Gold Coast; R W Crowther and D A W Walker, to be veterinary officers, Nigeria; Miss M E Broughton, to be marketing officer, Nigeria; F E Luscombe, to be agricultural officer, Tanganyika; C Harvey, senior agricultural officer, Fiji; to be director of agriculture, Fiji; E W Leach, senior agricultural officer, Nigeria, to be deputy director of agriculture, Trinidad; F S Collier, conservator of forests, Nigeria, to be deputy chief conservator of forests, Nigeria

LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications.

'Sensitizing' by Protective Colloids

THIS is the name given¹ to the following phenomenon. It was observed² that the addition of a quite small amount of a hydrophile colloid to a sol of a hydrophobe colloid caused the latter to be coagulated (precipitated) by a much smaller amount (at much lower concentration) of a precipitating electrolyte than in total absence of the protective colloid. However, suitable larger amounts of the latter made necessary larger amounts of precipitating electrolyte than in the absence of the hydrophile colloid, hence the term 'protective colloid' for the latter.

In a letter in *Nature* in 1921³ I suggested that many of the properties of the so-called (at that time) 'emulsoid colloids', and particularly of proteins, derived from a duplex character of their molecules in respect of their possessing both hydrophile polar and hydrophobe but organophile non-polar atom-groups. The conception was developed more explicitly in a monograph on gelatin⁴ to provide a basic *stratochemical* architecture for the micelles of proteins⁵.

Experimental evidence was presented from the effect of gelatin on the interfacial tension between water and toluene and from the sorption of gelatin at this interface out of dilute solutions⁶.

Recent investigations by me and my collaborators⁷ have shown that the adsorption of many basic dyes to silver halides occurs in two stages. In the primary—and priming—stage, the dye molecules are deposited in a mono-layer, with the polar or ventral (to suggest an anatomical image) aspect of the molecule (ion) adhering to the silver halide surface, and the hydrophobe (or dorsal) edge projecting into the aqueous solution. After saturation is effected, a second mono-layer begins to build on. This does not form a rigid but a reversible layer, of the Langmuir type, because now the non-polar hydrophobe aspects of the dye molecules are attracted each to each between solution and primary adsorbate, while the polar, hydrophile groups of the secondary layer are attached to the water.

There are complications attendant on the formation of dimerized and polymerized aggregates of the dye molecules which need not detain us here. What is important is that we now have evidence from direct adsorption measurements from dilute solution, as well as from experiments on the coagulation and reprecipitation of silver halide sols by dilute gelatin solutions, that a quite similar process to that with dyes occurs in the adsorption of proteins to the silver halides and other little-soluble polar solids.

The electrophoretic and kindred investigations of H. A. Abramson⁸ and many others have led to the general conclusion that "The fact that not only the isoelectric points but also the electric mobilities of quartz particles covered with serum albumin or egg albumin [or gelatin] are very nearly identical with the values of mobility for the respective dissolved protein indicates that practically all the polar groups of the protein molecules are available even after adsorption has occurred." The apparent paradox whereby the polar force fields of the protein should be quite free even when the molecules are at one and

the same time most tenaciously and strongly adsorbed⁹ to a polar surface is now explainable by our new observations, and the stratochemical layering. The electrical behaviour of the protein-coated silic particles etc., is due not to the primary mono-layer but to the secondary reversible layer.

It should be noted that the arrangement requires (of polar-nonpolar alternance, or 'amphipathy', to use Hartley's term) seems consistent with Astbury's X-ray diffraction conclusion that "polar and non-polar side chains follow one another alternately along the main chains" in the protein structure¹⁰.

The mechanism of 'sensitizing' evidently derives from the amphipathic character of the protective colloid, which is manifest not only in the proteins but also in such polyoses as the starches, dextrans, gums and pectins, and in kindred bodies, such as polyvinyl alcohol¹¹. Some part of the initial precipitating effect of these hydrophile colloids can be replaced by an alternate electrolyte—and vice versa. In all cases, the primary monolayer furnishes lipoid surfaces, coherence of which is coagulation. This is followed by reprecipitation by addition of further hydrophile colloid.

With my colleagues I shall deal with the subject more fully in subsequent publications.

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Dec 19

¹ Freundlich, H., "Kapillarchemie" (Auf. 2, Leipzig, 1922), 799 *et seq.* Also for non-colloidal non-electrolytes, *idem*, 636 *et seq.*

² Henri, V., *et al.*, *C. R. Acad. Sci.*, **55**, 1671 (1903).

³ Sheppard, S. E., *Nature*, **107**, 73 (1921).

⁴ Sheppard, S. E., "Gelatin in Photography" I Monographs on the Theory of Photography, No. 3 (New York: D. Van Nostrand Company, 1923), 188.

⁵ *cf.* also *Ind. and Eng. Chem.*, **13**, 37 (1921).

⁶ Sheppard, S. E., and Sweet, S. S., *J. Amer. Chem. Soc.*, **44**, 2797 (1922).

⁷ Sheppard, S. E., *Atti X. Congress Internat. di Chim.*, **VI**, 234 (1938); also Sheppard, S. E., Lambert, R. H., and Walker, R. D., *J. Chem. Phys.*, **7**, 265 (1939).

⁸ Abramson, H. A., "Electrokinetic Phenomena" (*Amer. Chem. Soc. Monog.*), 1934.

⁹ *cf.* Sheppard, S. E., Lambert, R. H., and Keenan, R. L., *J. Amer. Chem. Soc.*, **56**, 174 (1932).

¹⁰ Astbury, W., *J. Chem. Soc.*, 337 (1942).

¹¹ *cf.* Sheppard, S. E., and Newsome, P. T., *J. Chem. Phys.*, also Pt. 2 (in the press, *ibid.*)

Age of the Saline Series in the Punjab Salt Range

PROF. B. SAHNI's important observations¹ have necessitated a reconsideration of this problem. In order to review the geological evidence on the ground, an excursion was arranged to examine several sections which had led E. R. Gee, of the Geological Survey of India, and other geologists to the conclusion that the Saline Series of the Salt Range is of Cambrian or pre-Cambrian age. Prof. Sahni was unfortunately unable to take part in the excursion, the party consisting of the undersigned.

The sections visited were near Khewra in the eastern part of the range, and in the Warcha-Sakesar area of the middle western portion. This examination showed that an Eocene or later age for the Saline Series is irreconcilable with the field evidence, which, in our opinion, indicates that this series is Cambrian or older.

The junction of the Saline Series and the overlying Purple Sandstones (Cambrian or older) is in several sections conformable and transitional. This is well seen in exposures east of the Warcha Circuit House.

The junction of the Upper Carboniferous Talchir Boulder Bed with various stages of the Cambrian and the Saline Series was examined over several miles of its outcrop south of Sakesar. Here also our opinion is that this junction is normally an ordinary sedimentary overlap, thus precluding an age for the Saline Series later than Talchir.

Regarding the evidence of Tertiary to sub-recent fossils found by Prof Sahni, we observed so many instances, even deep in the salt mines, of sub-recent material being enveloped in the salt and in the marls, that it seems possible Prof Sahni's fossils had a similar origin, notwithstanding that in many cases they have every appearance of being *in situ*. Our conclusions were arrived at despite the recognition of certain difficulties, such as the occurrence of minute plant fragments of post-Cambrian age in the dolomites and oil shales, for which at present we have no clear explanation to offer.

The Foraminifera, formerly believed to indicate an Eocene age for the Saline Series², were later proved to be derived material embodied in outcrops as a result of subsequent movements.

J COATES P K GHOSH
H CROOKSHANK. E. LEHNER
E R GEE E S PINFOLD.

Warcha
Nov 10.

¹ Sahni, B., *Nature*, 153, 462 (1944)

² Davies, L. M., *Nature*, 154, 53 (1944)

Synergistic Effect of Cod Liver Vitamin D on Synthetic Vitamin D₃

ALTHOUGH the average vitamin D content of cod liver oil of authentic origin as produced by the world's fisheries in normal peace-time lies in the neighbourhood of 85 international units per gram, there are very wide limits of variation according to the season, condition of the fish in relation to spawning and the actual fishing ground on which the fish are caught. In our experience these natural variations cover a range from below 50 to above 500 international units per gram.

Experience with authentic cod liver oils shows that when oils of widely differing vitamin D potency are blended, the vitamin D content of the blend is in harmony with the calculated figure derived from the individual potencies of the components of the blend. This would be agreed as a matter of common experience.

On the other hand, we find that when synthetic vitamin D₃ is blended with cod liver oil, the assay in international units is higher than the calculated figure. Two typical results of tests using eighteen pairs of rats in each biological assay are given below.

Vitamin D content of the cod liver oil	Amount of synthetic vitamin D ₃ added to 1 gm of cod liver oil	Calculated vitamin D potency of the resulting mixture	Actual vitamin D potency of the resulting mixture
(I U/gm)	(I U)	(I U/gm)	(I U/gm)
90	80	170	206
84	81	165	245
89*	67	156	227

* Average figures for a comprehensive series of thirteen similar blends, using eighteen pairs of rats for each assay.

It is not the purpose of this letter to offer any final explanation of the apparent synergism between the vitamin D of cod liver oil and synthetic vitamin D₃. It is known, however, that the vitamin D of cod liver oil, often presumed to be a single substance is really a complex. Bills¹ and other workers have shown that there are at least seven forms of vitamin D. Hickman and Gray² have demonstrated by short-path distillation the possibility of there being at least six different substances in cod liver oil with antirachitic properties. On the other hand, the known synthetic forms of vitamin D are apparently individual substances which can, in fact, be crystallized in the pure state.

If the full activity of vitamin D as a therapeutic substance used to cure experimental rickets in rats depends on the simultaneous presence of more than one component, then vitamin D₃ itself, by reason of its singleness of nature, would not exert its full curative action until one or more of the other essential components of the vitamin D complex are adequately represented in the blend.

These observations have very wide implications especially in view of the different efficiencies for rat and chickens respectively of vitamin D₂ and various fish liver oils. In any event, vitamin D₃ can apparently become much more effective for rats if the vitamin D complex of cod liver oil is fed simultaneously to the experimental animals. It is a matter for further investigation as to whether the synergism of the type described between the vitamin D of cod liver oil and vitamin D₃ is general, or whether it is confined to the specific case of experimental rickets in rats.

W STOTT.

CYRIL C HARRIS

Biological Testing Station,
British Cod Liver Oil Producers (Hull), Ltd.,
Hull Jan. 15

¹ Cold Spring Harbor Symposia on Quantitative Biology, 3, 328 (1935)

² *Ind Eng Chem*, 30, 796 (1938)

Diabetogenic Action of Alloxan Derivative

THE finding of Shaw-Dunn and co-workers¹ that alloxan (and a styryl-quinoline) causes diabetes by damaging the pancreatic islet cells has since been amply confirmed in a number of laboratories, working with various animal species. Attempts to discover other substances with similar action have so far been unsuccessful, nor has any explanation been offered regarding the mechanism by which alloxan attacks the β -islet cells.

During an investigation of this question, a number of substances, all closely related to alloxan, were found to produce diabetes in rats when injected intravenously. These substances were methylalloxan, alloxantin, dimethylalloxantin, diuric acid, methylallic acid. Dimethylalloxan and dimethylallic acid (as sodium salt) were found to be highly toxic, the initial symptoms suggesting vagus stimulation, and did not cause diabetes in doses up to 100 mgm. per kgm. body-weight of rat. Renal damage, as judged by albuminuria and uraemia which was more or less evident with all these compounds including alloxan, was particularly pronounced with dimethylalloxan. Other disubstituted alloxans are now under investigation.

Diabetogenic action was not caused by tartronic acid, dimethylalloxanic acid (in which the fissure

the pyrimidine ring caused disappearance of the toxicity), alloxanic acid, violuric acid and murexide, the last three compounds having already been proved non-diabetogenic by several authors^{2,3,4}

It is of interest that the minimum effective diabetogenic dose is about the same with all these compounds, including alloxan namely, 50-70 mgm per kgm body-weight. This dose resulted in the development of extreme hyperglycaemia, glucosuria, polyuria and occasional ketonuria within 12-24 hours. These findings may indicate a very rapid conversion of alloxan to dialuric acid or vice versa, and an equally rapid decomposition of alloxantin. Alternatively, all these compounds might have some property in common, which enables them to interfere with processes within the pancreatic islet cells.

One of the best-known properties of alloxan and some of its derivatives is the decarboxylation and desamination of amino-acids, discovered by Strecker⁵ in 1862. We have examined some other substances which give the Strecker reaction. Ninhydrin, which is very toxic, did not produce diabetes in rats, nor did isatin, which is very sparingly soluble.

All the above diabetogenic substances were found to react *in vitro* with haemoglobin. The alloxans were methaemoglobin formers, while the alloxantins and dialuric acids rapidly converted oxyhaemoglobin into reduced haemoglobin and blackish-green decomposition products, probably bilirubinoid in nature. The latter effect was also observed *in vivo* with some of the dialuric acids. The alloxans, on the other hand, when given in normal dosage, failed to induce noticeable methaemoglobin formation in rats.

In conclusion, it may be mentioned that Jacobs² and Goldner and Gomori³ have reported negative results in attempts to produce diabetes with alloxantin and dialuric acid, using rabbits and dogs respectively. With a dosage of 150 mgm (super-saturated solution) dialuric acid per kgm we have, however, obtained diabetes in a rabbit after intravenous injection.

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³ Goldner, M. G., and Gomori, G., *Endocrinology*, 35, 241 (1944)

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Liberation of H^+ , Al^{+++} and Fe^{+++} Ions from Hydrogen Clays by Neutral Salts

THE interaction between hydrogen clays and neutral salts gives rise to H^+ and Al^{+++} and, in a secondary measure, Fe^{+++} ions in the salt extracts. The mechanism of this reaction has been the subject of much discussion¹⁻⁸. Some investigators¹⁻⁵ consider that the acid liberated by the salt dissolves Al^{+++} and Fe^{+++} ions from the sesquioxides present in the hydrogen clay, while others⁶⁻⁸ postulate a direct exchange of Al^{+++} and Fe^{+++} ions for the cations of the added salt.

A number of publications⁹⁻¹² from this Laboratory have dealt with the liberation of Al^{+++} ions from hydrogen clays isolated from Indian soils by various neutral salts. At a constant pH the amounts of dis-

placed Al^{+++} ions (A) have been found to increase with the concentration (C) of the added salt. The plot of A against C has the shape of the usual adsorption isotherm. At a given equilibrium pH, barium chloride liberates a much larger quantity of Al^{+++} than hydrochloric acid. All these observations indicate a direct exchange of Al^{+++} ions for the cation of the salt, instead of their liberation by a secondary dissolution process. A direct exchange of both H^+ and Al^{+++} has been observed. At low values of C, very few Al^{+++} ions and mainly H^+ ions are exchanged. With an increase in C, the amounts of both displaced H^+ and Al^{+++} ions increase, but that of the latter at a relatively greater rate than the former. A relation has been found between A and the base-exchange capacity (B), calculated at the inflexion points in the titration curves with sodium hydroxide, of subfractions of hydrogen clay isolated from the same entire clay fraction. Both A and B usually increase with diminishing particle size. Any deviation from this regular variation in A with the particle size is also reflected in similar deviations in the case of B¹³. Depending on the nature of the hydrogen clay, an increase as well as a decrease in A accompanied by similar variations in B have been observed on the removal of free inorganic oxides present in the hydrogen clays according to the method of Truog *et al*¹⁴. The decrease in A and B probably indicates a decomposition of the absorption complex.

The amounts of H^+ , Al^{+++} and Fe^{+++} displaced from hydrogen clays Satara-F and Jorhat-F prepared respectively from a black cotton and an acid soil decreased to almost negligible values on continued leaching with a normal solution of barium chloride. But the above cations were liberated, as often the barium clay thus obtained was rendered desaturated by treatment with 0.02 N hydrochloric acid and then leached with a solution of N-barium chloride. Much smaller quantities of the cations were displaced from the desaturated clays compared with the original hydrogen clays. In the case of the hydrogen clay Satara-F, which contains the clay mineral montmorillonite, judged from X-ray studies¹⁵, and certain viscous¹⁶ and electrochemical criteria^{17,18}, the total amount of acid in its 'leachates' decreased progressively with successive desaturations. With the hydrogen clay Jorhat-F, containing mainly kaolinite and a very small quantity of montmorillonite, it tended to a constant value. The amount of Al^{+++} ions displaced from Satara-F decreased up to the fifth desaturation and then increased. In the case of Jorhat-F it decreased up to the fifth desaturation and then became constant. Very little (0.5 to 0.4 milli-equivalents per 100 gm of oven-dry hydrogen clay) Fe^{+++} ion was displaced by N-barium chloride from the two hydrogen clays. But with Satara-F its amount increased with successive desaturations up to the fifth one and then began to decrease. In the case of Jorhat-F it remained practically constant. The sum of the amounts of displaced Al^{+++} and Fe^{+++} ions decreased with progressive desaturations, tending to a constant value with both the hydrogen clays. After the full cycle of operations (eight desaturations in the case of Satara-F and six with Jorhat-F) a marked reduction¹⁹ in base exchange capacity (B) of Satara-F was observed. Jorhat-F showed no material change¹⁹. The observed reduction in B indicates a decomposition of Satara-F. X-ray diagrams obtained by Mr S. N. Bagchi¹⁵ gave no lines characteristic of montmorillon-

ite in the hydrogen clays at the end of the above cycle of operations. A relation between the mineralogical composition of the clay and the quantities of displaced Al^{+++} and Fe^{+++} ions is indicated by the above results. Further work with pure clay minerals is in progress.

These investigations have been carried out with the aid of a grant from the Imperial Council of Agricultural Research, India

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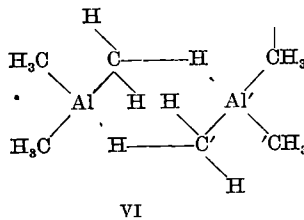
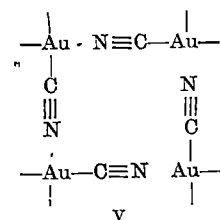
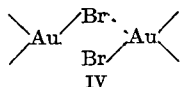
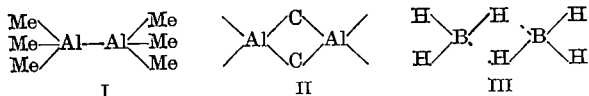
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Structure of Aluminium Trimethyl

THE existence of the dimer aluminium trimethyl has aroused considerable interest. Electron diffraction determinations^{1,2} are in satisfactory agreement with an ethane structure (I). However, this structure is for many reasons most unlikely: (1) it should differ from the bridge structures of the related aluminium halides³ Al_2X_6 , aluminium dimethylhalides² $\text{Al}_2\text{Me}_4\text{X}_2$, as well as of the boron and probably aluminium hydrides⁴, (2) it cannot be accounted for by any existing valence theory, no forces are available for joining the two AlMe_3 molecules, (3) it requires a shorter interatomic distance (about 2.20 Å) between the equally charged Al atoms than that of a covalent Al-Al linkage (> 2.48 Å), (4) the unstability (non-existence) of a dimer boron trimethyl cannot be explained



Raman spectra favour a bridge structure⁵, but that of type II is excluded by the results of electron diffraction determinations². As shown elsewhere⁶, the stability of B_2H_6 and Al_2H_6 can be accounted for on the basis of the bridge structure⁴ by the formation of B...H hydrogen bonds (of an essentially electrostatic nature) (III). This also allows a bridge structure for Al_2Me_6 , which has not yet been considered (VI). A six-membered ring is formed by Al...H hydrogen bonds. Owing to the inductive electron transfer from the positive Al atom, the negative charge on the H atom should be appreciable. The non-existence of B_2Me_6 can be explained by the much smaller electron transfer from the less-positive B atom, which is not compensated by the expected shorter interatomic distance. Al_2Me_6 is now no exception to the bridge structures of its related aluminium and boron derivatives. This is comparable to the dimer gold dialkyl halides and tetramer cyanides⁷, where one atom (halogen) (IV) and two atoms ($\text{C}\equiv\text{N}$) (V) respectively form the bridge. No new valence theory is required, and the Al-Al distance is now longer than that of a covalent linkage.

It is noteworthy that the distances to be expected for structure VI are in qualitative agreement with the peaks of radial distribution curves derived from electron diffraction determinations, which are 2.07, 2.6, 3.42, 3.93¹ and 2.01, 2.58, 3.3, 4.05 Å respectively². The C-H and Al-C distances within the six-membered ring will be near 1.09 and 2.01 Å respectively, the Al...H distance slightly longer than that of a covalent linkage and not very different from (1.7) 1.8 Å. Making the reasonable assumption that the angles CAIH and AICH in the ring are about 109.5°, the important distances mainly contributing to the radial distribution curve below 4 Å are Al-C 2.01 Å, Al-C' 2.73 Å, Al-H 2.59 Å, Al-Al' 3.22 Å, C-C 3.28 Å, C-C' (both in ring) 3.5 Å, C (in ring)-C (outside ring) 4.0 Å. These distances show a reasonable relationship to the observed peaks. This should justify new quantitative calculations, based on the suggested bridge structure, for testing such model and possibly establishing its actual dimensions.

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Mechanism of the Red Cell Changes in Non-hæmolytic Jaundice

CERTAIN characteristic changes are found in the erythrocytes in obstructive jaundice. The red cells are increased in diameter but not in thickness, so that they are relatively flat cells. Associated with this alteration in shape, target cells are seen in the blood in large numbers and the red cells are resistant to hæmolysis by hypotonic saline solutions. The volume of the cells may or may not be increased.

The same changes have been demonstrated in cases of toxic-infective jaundice. Here, in most

instances, the presence of some obstruction to the outflow of bile is indicated by the clinical features of dark urine and pale stools and a positive van den Bergh test in the serum

It has been shown that the changes in the erythrocytes occur as the result of alterations in cells that are already circulating in the blood at the onset of the jaundice, and not because of altered erythropoiesis

The changes in the red cells may be present to a marked degree as early as ten days after the onset of the jaundice. The possibility of this being the result of a new generation of cells is precluded by the fact that erythropoiesis would have to proceed at about ten times the normal rate, and yet no increase in the reticulocytes is seen. Likewise, in recovering cases the blood is restored to normal in as little as ten days, again without signs of rapid cell regeneration

If red cells are transfused into a jaundiced patient, the transfused cells can be shown to take on the characters described above in about a week. Some mechanism, therefore, exists for producing these changes in circulating red cells

The bone marrow in jaundice shows no abnormality that could be responsible for the alterations found in the circulating cells

Detailed analysis of the changes in the chemical constitution of the blood in non-haemolytic jaundice shows that none of these alterations is responsible for the changes in the red cells

It is suggested by comparison with the red-cell changes found after splenectomy that the changes in the erythrocytes in jaundice of the non-haemolytic variety are due to functional disturbance in the circulation of the spleen in jaundice

Changes in circulating erythrocytes in the direction of roundness in cases of haemolytic anaemia have received much prominence in recent years. It is suggested here that the opposite change, flattening, also results from alterations in cells as they circulate in the peripheral blood stream

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Siderocyte Levels in 'Normal' Human Beings

FOLLOWING the partial elucidation of the physiological properties of the siderocyte as the normal ageing erythrocyte¹ and in view of pathological studies now in progress, it became desirable to establish 'normal' siderocyte levels in human beings, and to study the effects of sex, age, menstrual cycle, diurnal variation, iron therapy and exercise upon such levels.

Below are summarized the results of such an investigation carried out in the University of Birmingham.

The differences of the means between the age-groups in the female do not at any point attain statistical significance, but the first and last age-groups in the male do attain a significant difference of mean from their neighbouring groups. The difference between the means for the male and female is also significant. Both series, grouped in 0.1 per cent siderocyte-class intervals, approximate fairly well to normal distributions

Daily siderocyte counts throughout two successive menstrual cycles in each of two female subjects showed no cyclical tendency. Hourly siderocyte

AN ANALYSIS OF SIDEROCYTE LEVELS IN 279 'NORMALS' BETWEEN THE AGES OF 5 AND 65 YEARS

Total series

Age group	5-	15-	25-	35-	45-	55-65	All ages
Number of subjects	32	118	46	30	29	24	279
Mean (%)	0.37	0.52	0.48	0.56	0.52	0.48	0.50
S.D.	0.29	0.24	0.29	0.23	0.25	0.15	0.25
Coefficient of variation	77%	47%	62%	41%	48%	31%	50%

Male series

Number of subjects	16	68	24	17	17	12	154
Mean (%)	0.32	0.50	0.41	0.53	0.51	0.40	0.46
S.D.	0.15	0.23	0.27	0.19	0.28	0.15	0.23
Coefficient of variation	48%	45%	66%	36%	57%	37%	50%
P for diff of successive means	0.01	0.15	0.15	0.8	0.001		

Female series

Number of subjects	16	50	22	13	12	12	125
Mean (%)	0.43	0.55	0.55	0.59	0.55	0.57	0.54
S.D.	0.29	0.26	0.31	0.25	0.21	0.10	0.27
Coefficient of variation	77%	48%	57%	46%	37%	17%	50%
P for diff of successive means	0.15	0.9	0.65	0.65	0.8		

Grand mean Male 0.46, Female 0.54, Difference 0.08 $P = 0.01$

counts on six subjects revealed no evidence of diurnal variation. The exhibition of fairly large doses of ferrous sulphate (up to 1,500 mgm iron daily) for periods up to 21 days did not affect siderocyte levels in four subjects

Moderately severe exercise (sprinting 440 yards) produced no change in level immediately afterwards in each of four subjects, but the injection of small doses of adrenalin, which is without effect on blood *in vitro*, produced an immediate but transient rise of up to 2 per cent, falling to normal in 1½ hours, in six subjects. In our view, this response is probably due to splenic contraction, since Granick² has shown numerous siderocytes in teased spleen preparations.

Siderocytes are thus shown to be normal and constant inhabitants of circulating peripheral blood in normal human beings, there being a slight sex difference in level. For most practical purposes, however, a value of 0.5 ± 0.3 per cent will serve as the 'normal' level for human beings above the age of five years. Higher levels have been reported in infants³, but so far no information is available as to when the level becomes stabilized.

Exercise, iron therapy, and menstruation do not appear to influence the siderocyte levels herein established, nor do they show diurnal variation.

Full details of this investigation will be published elsewhere

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¹ Case, *Nature*, 152, 599 (1943)

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Structure and Nutrition of the Cornea, Cartilage and Wharton's Jelly

We have read with great interest the letter by Barcroft *et al.*¹ Barcroft and his co-workers observed the passage of large molecules in Wharton's jelly of the umbilical cord of foetal sheep, and they believe that there exists a non-vascular pathway through which nourishment travels along from the placenta towards the foetus. While there seems to be every justification for this interpretation of the findings, we are of the opinion that this easy and relatively fast passage of large molecules may contribute to the nutrition of Wharton's jelly itself. With a few exceptions² (apart from the large umbilical vessels, which are not supposed to give off nourishment for the surrounding tissues) the substance of the umbilical cord is completely avascular. In this respect Wharton's jelly is closely similar to cartilage and the cornea. It is generally accepted that both cartilage and the cornea are nourished by diffusion from the surrounding tissues, and it seems to us that to assume a similar method of nourishment for Wharton's jelly is entirely justifiable. Both Wharton's jelly and cartilage are rich in two closely related substances, mucotin sulphuric acid and chondroitin sulphuric acid respectively.

Some months ago our attention was directed to the work of Jorpes *et al.*³ describing the presence of heparin in the substantia propria of the human and bovine cornea. This observation was based on the metachromatic staining reaction of the substantia propria corneae after toluidin-blue staining. We repeated this method on sections of rabbit, guinea pig, rat and normal human corneae, and we confirmed the presence of a metachromatic substance. The reaction in the rabbit's cornea, especially after the use of basic lead acetate as a fixing agent, was particularly intense. This staining reaction is strictly confined to the cornea and stops sharply at the corneo-scleral junction. While the real chemical basis of this reaction can be proved only by micro-chemical analysis, it appears justifiable to suppose that the substance responsible for the specific staining reaction is either heparin, which is a mucotin polysulphuric acid, or a chemically allied substance, because only these substances give a metachromatic staining reaction with toluidin-blue.

The presence of metachromatic substances in the substantia propria corneae is not given in standard histological descriptions, although muco-protein was found by Morner⁴ and mucotin sulphuric acid by Levene⁵ after chemical analysis. Krause⁶ in his book on the biochemistry of the eye, referring to the above findings, states that the part played by these acids in such "metabolically inactive" tissue as the substantia propria is not known.

It is of interest that the mast cells, which, according to Jorpes *et al.*³ are responsible for the production and the maintenance of the heparin level of the circulation, give a particularly vigorous metachromatic staining, and consequently the intensity of metachromasia displayed by these chemically related substances can be used within certain limits as a starting point for chemical differentiation.

As previously stated, the cornea derives its main nutrition by diffusion from the margin. We have found numerous mast cells around the capillary loops at the limbus corneae, and we believe that these cells facilitate diffusion and nutrition by maintaining a

high heparin concentration. The translucency of the cornea may also be maintained by and dependent upon the presence of heparin, or some chemically related substance.

The cornea, cartilage and Wharton's jelly are avascular structures, and they all contain similar or closely related metachromatic substances. They all bear the same peculiar relationship to their blood supply, and consequently their nutrition must be similar. Our assumption gains support from the findings of Barcroft *et al.*¹

Finally, it is significant that the cornea is the only tissue with which successful homografting can be carried out, and the explanation may lie in its chemical structure and peculiar nutritional conditions.

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¹ Barcroft, J., Danielli, J. F., Harper, W. F., and Mitchell, P. D. *Nature*, 154, 667 (1944).

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³ Jorpes, J. E., Holmgren, H., and Wilander, O., *Z. Mikroskop.-anat. Forsch.*, 42, 279 (1937).

⁴ Morner (quoted by Krause).

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⁶ Krause, A. C., "The Biochemistry of the Eye" (Baltimore, 1934).

Mechanism of Bacterial Flocculation caused by Protozoa

WITHIN the last two or three years several investigators¹⁻⁴ have reported in these columns that certain Protozoa growing in sewage possess the power of causing flocculation of the bacteria on which they feed, a property which is obviously of value to the organisms themselves, since it facilitates the collection of food bacteria, and may also be of importance in sewage purification.

So far as I am aware, the mechanism of this peculiar phenomenon has not been described. In the holotrichous ciliate *Balantrophorus minutus*, the ability of which to cause such flocculation has already been recorded⁵, it has been found that the feeding mechanism involves the production of mucus secreted within the peristome, to which the food bacteria adhere before being ingested, and are thus prevented from being swept out of the peristome by the ciliary currents. This mucus has been found gradually to accumulate in the culture-fluid and, not being a diffusible substance, remains in the neighbourhood of the ciliates themselves. The resulting local increase in the viscosity of the culture medium causes the entanglement and flocculation of the bacteria. When flocula from *Balantrophorus minutus* cultures are examined under the microscope, the bacteria are seen to be cemented together by an amorphous substance which, upon staining with methylene blue with mucicarmine and Delafield's haematoxylin, or with safranin, shows the metachromatic effect characteristic of mucus with these dyes. Control cultures of the same mixed bacterial flora which have not been inoculated with the ciliate show no flocculation, and smears, upon staining, give sharp monochromatic coloration, no matrix being visible between the bacteria.

This matter is dealt with more fully in another publication at present in the press

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¹ *Nature*, 151, 642 (1943)

² *Nature*, 150, 525 (1942)

³ *Nature*, 154, 179 (1944)

⁴ *Nature*, 150, 607 (1942)

⁵ *Nature*, 152, 693 (1943)

Effect of Temperature on Fertility of the Male

EXPERIMENTAL work on many mammals, including dogs, rabbits, cats, rams and bulls, has shown that in those species with the testicles enclosed in an external scrotum, there is normally a significant temperature difference between the testicles and the body. This temperature difference varies in different species from 1° to 8° C and is essential for the proper functioning of the testicles. If the temperature of the testicles is artificially raised to body temperature, sperm production is greatly lowered and the animals concerned may to all intents and purposes become sterile. There is, of course, no diminution of desire.

The experiments of Young¹ may be cited as typical of the work which has been carried out on this subject. Young ran hot water (46–47° C) over the testicles of guinea pigs for periods of 15–30 minutes. He found that some degeneration of the germinal epithelium began immediately and that the consequent diminution of fertility was apparent for twelve days.

This knowledge has important practical application in animal breeding. For example, the sterility of a valuable strain of rams in Australia was shown recently to be due to nothing more than a thick growth of wool on the testicles. When this source of warmth was removed, the fertility of the rams was restored. The sterility of an undescended testicle is apparently due to its being kept at body temperature. If the testicle can be massaged down into the scrotum, it produces sperms.

McLeod and Hotchkiss have reported² experiments in this connexion on the human subject. Healthy young men were exposed in a fever cabinet to a temperature of 110° F for a period of 32 minutes. For eighteen days after the experiment, their sperm counts remained at a normal figure of 300–400 million. The counts then fell to as low as 20 million and remained subnormal for sixty-seven days. Medical evidence quoted in the same paper indicates that with a sperm count less than 60 million a man is almost certainly sterile.

No mention was made in McLeod and Hotchkiss's paper of the possible adverse effects of hot baths on mature males. I investigated this important possibility. The matron of a London hospital told me that the temperature of a patient's bath is about 105° F, which is well above body temperature. The temperature of a domestic hot bath is nearer 110° F, the temperature of the fever cabinet experiments. Dr John Hammond, with whom I discussed this problem, is of the opinion that such a temperature might reduce human male fertility. He added the interesting information that the fertility of white men is much reduced in the tropics, and that more native children are conceived there in the cooler months. Dr. John Baker, of the School of Compara-

tive Anatomy, Oxford, has raised the question of the possible adverse effects of hot baths purely on the evidence of work on lower mammals³.

It is not suggested that the hot-bath habit is the sole cause of male infertility, but it would seem to be a fruitful line of research, according closely as it does with the general rise in male infertility, the reduction of the birth-rate in 'civilized' as opposed to backward nations, the greater reduction of the birth-rate in the richer sections of the community and the peculiar fall given to the birth-rate by the present War and the War of 1914–18.

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¹ *J. Expt. Zool.* (1927)

² *J. Endocrin.* (1941)

³ *J. Hyg.*, 27 (1928)

Naturally Occurring Polyesters

MAY I add to the recent note¹ on the isolation of a natural elastic polyester²? The natural occurrence of polyesters was observed as early as 1908 by Bougault and Bourdier³, who showed that the waxes obtained by extraction of the leaves of a variety of conifers are linear polyesters of hydroxy-acids such as juniperic acid (ω -hydroxypalmitic acid) and sabmic acid (ω -hydroxylauric acid). These polyesters, or 'etholides', have average molecular weights of the order 1,000–2,000, and were afterwards shown to have the same general properties as the synthetic polyesters obtained by heating ω -hydroxy-monocarboxylic acids⁴. The average molecular weights of the natural esters show that they belong to the α -polyester type rather than the ω - or linear superpolyester type synthesized by Carothers and Hill⁵. Bougault appreciated the analogy between the etholides on one hand and polysaccharides and polypeptides on the other.

The etholides (natural and synthetic), which are polyesters derived from the self-condensation of ω -monohydroxy-monocarboxylic acids, are to be distinguished from the second class of linear polyesters synthesized by Carothers and Arvin⁶ by the condensation of dihydric alcohols and dicarboxylic acids. The properties of the natural elastic polyester constituting the skin enclosing the seeds of *Smilax rotundifolia* indicate that it is not a linear polyester but that a degree of cross-linking of the polymer chains occurs².

Kemp and Peters suggest that the principal hydrolytic product of the polyester, an acid of the approximate molecular formula $C_{16}H_{32}O_6$, is a trihydroxy-monocarboxylic acid, if this suggestion is correct, the elastic properties of the natural polymer may be reproduced in synthetic polyesters derived from polyhydroxymonocarboxylic acids.

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¹ *Nature*, 154, 762 (1944)

² Kemp and Peters, *India Rubber World*, 110, 639 (1944)

³ *C.R.*, 147, 1311 (1908), 150, 874 (1910), 186, 1746 (1928), *J. pharm. chim.* [6], 29, 561 (1909), 30, 10 (1909), [7], 1, 425 (1910), [7], 3, 101 (1911)

⁴ Lycan and Adams, *J. Amer. Chem. Soc.*, 51, 635, 3450 (1929) Chunt and Hauser, *Helv. Chim. Acta*, 12, 463 (1929)

⁵ *J. Amer. Chem. Soc.*, 54, 1559 (1932)

⁶ *J. Amer. Chem. Soc.*, 51, 2560 (1929)

Non-luminous Flame Gases

AFTER flame has travelled through a homogeneous flammable mixture, the gases left behind ('flame uses') rapidly reach what is for all practical purposes state of equilibrium. The flame gases (like ordinary open flames) are in general luminous, and their temperatures as determined by (i) calculation, (ii) fine platinum wires and (iii) quartz-covered platinum wires of the same overall diameter, differ by hundreds of degrees C. Typical temperature measurements made with combustible gas-air mixtures during the re-pressure period in large closed-vessel explosions by means of wires of 0.0005 in diameter are given in the accompanying table. We think that the explanation is that a proportion of the tri-atomic molecules formed during combustion holds in very stable fashion an excess of energy (probably in virtue of abnormal structure), and because of this an abnormal dissociation takes place, the products of which combine on the plain platinum surface^{1,2}.

	Temperatures (°C)	
	28% Carbon monoxide	9% Methane
Calculated	2110	1860
Platinum ..	1790	1680
Quartz	1440	1360

In the special case of inflammable mixtures with a very large excess of combustible gas, the abnormal dissociation appears to be suppressed in the flame gases, for the plain and quartz-covered wires yield exactly the same temperatures. These temperatures are far lower than the calculated temperatures¹, and, of course, the flame gases are luminous. When, however, such mixtures undergo combustion in a tube, the flame gases, although luminous after the early stages of flame-front travel from the igniting spark, suddenly become non-luminous after further travel due apparently to a sudden change in the mode of combustion in the flame front¹. This rather remarkable phenomenon is vividly demonstrated in the flame photograph shown in Fig 1, which was taken on a moving film during the explosion of a mixture (88 per cent carbon monoxide plus 12 per cent oxygen) in a glass tube.

We have recently completed a series of plain and quartz-covered wire temperature measurements with such mixtures in a closed iron tube 12 ft in length and 4 in in internal diameter. The wires were placed axially along the tube at various points up to 20 in from the igniting spark. The results for a mixture (90 per cent carbon monoxide plus 10 per cent oxygen) are shown in Fig 2. It will be seen that when the flame gases are luminous the wire tempera-

tures are more than 200° C. below the calculated temperature, whereas after 15 in (when the flame gases are presumably non-luminous) they are much greater and are nearly equal to the calculated temperature—indeed even more so than appears, for the wire temperatures are given as measured and have not been corrected for radiation loss either from the flame gases or from the wires. It would appear, therefore, that non-luminous flame gases, unlike ordinary flame gases, are just hot normal gases.

It may be of interest to point out that the flame photographs of Bone and Frazer suggest that non-luminous flame gases are also produced immediately after detonation is set up³.

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¹ *Proc Inst Mech Eng*, 151, 236 (1944) and other papers referred to therein

² *Phil Mag*, 34, 816 (1943)

³ *Phil Trans Roy Soc*, 230, 363 (1931), Photographs Nos 5, 17, 22 and 32

Effect of Length on Tensile Strength

THE results of a large number of tension tests on nominally identical test pieces can conveniently be represented by a frequency curve in which the ordinate gives the frequency of occurrence of test pieces the strength of which is represented by the abscissa. The frequency of occurrence of test pieces the strength of which falls between the limits $x + dx$ and x is given by $f(x)dx$. When the frequency curve is integrated with respect to x and between the limits $-\infty$ and x , an integral curve is obtained the ordinate $F(x)$ of which gives the proportion of test pieces with strength less than x . The proportion of test pieces with strength greater than x is given by $1 - F(x)$. Where the frequency curve does not depart greatly from normality, its characteristics can conveniently be summarized by its mean (μ), standard deviation (σ) and skewness $\sqrt{\beta_1}$.

It is of interest to derive the distribution of strength of rods the length of which differs from those tested. Consider first the strength of rods which are n times as long as those tested.

If the material is statistically homogeneous, such rods can be regarded as being composed of n rods of unit length chosen at random and placed end to end. Fracture will occur when the breaking load of the weakest of the n rods is reached. Owing to the predominance of low results, it would be expected that the mean strength would be lower and that the distribution would be more negatively skew than the distribution for the unit test pieces, and that the standard deviation would be lower. If $F_1(x)$ and $F_n(x)$ are the probability integrals for the strength of test pieces of length 1 and n units respectively, the distribution of the strength of the long test pieces is obtained by calculating the chance that n unit test pieces chosen at random shall all be stronger than a given strength, for this is the chance that the weakest of n test pieces shall exceed the given strength.

Thus $1 - F_n = (1 - F_1)^n$. This result was given by Pierce¹.

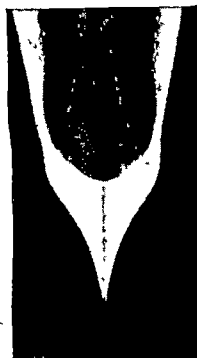


Fig 1

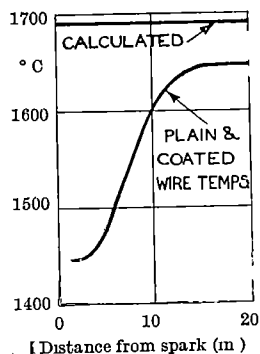
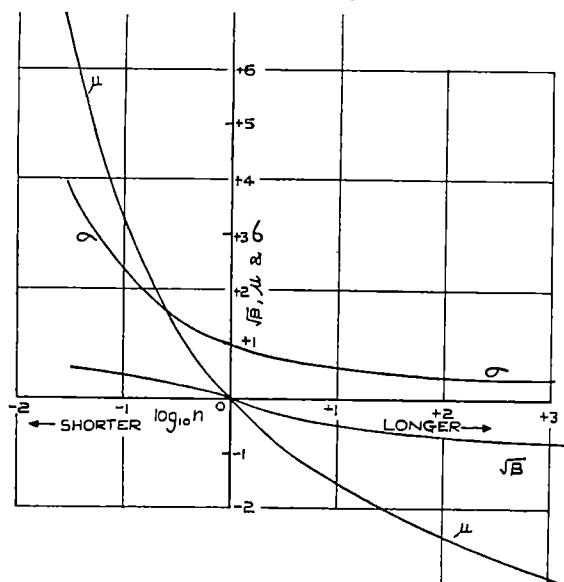


Fig 2



DISTRIBUTION PARAMETERS WHEN UNIT CURVE IS NORMAL

The similar problem of determining the distribution of strength of test pieces shorter than the unit test piece does not seem previously to have been treated. Consider each unit test piece as divided up into m equal parts, and consider the distribution of strength which would be expected if each part were tested separately. Each strength figure, which had previously been obtained for the unit test pieces, would again be obtained, and associated with each of these strengths there would be $(m-1)$ results of higher strength.

Owing to the predominance of high results, it would be expected that the mean strength and standard deviation of the distribution of the shorter test pieces would be greater than those of the distribution of the unit test pieces, and that the curve would be positively skew. The probability integral for the short test pieces ($F^{1/m}$) is obtained by stating that the distribution of the least of the strengths of m test pieces taken at random is the same as the distribution of strength of the unit test pieces. Thus

$$\left(1 - F \frac{1}{m}\right)^m = 1 - F_1,$$

$$\text{or } 1 - F \frac{1}{m} = (1 - F_1)^{1/m}$$

It is thus seen that the same formula holds for n less than unity (equal to $1/m$) as for n greater than unity. In the special case in which the distribution of the strength of the unit test pieces is normal, the characteristics of the distribution for other lengths have been computed and are shown in the accompanying curve. For n integral the results given by Tippett² have been used, while for n fractional the results have been worked out using Sheppard's Tables³. Values of the normal distribution beyond the range given in these tables were required and these were evaluated by Sheppard's method. The unit of the ordinates of the curves of σ and μ is the standard deviation of the distribution of strength of the unit test pieces. To obtain the mean strength of test pieces of given length, the appropriate value of μ multiplied by the standard deviation of the unit

distribution must be added to the mean of the unit distribution. From the graph it is seen that both mean and standard deviation increase rapidly for fractional lengths and decrease more gradually for integral lengths. For lengths greater than unity, the distributions are negatively skew, and for lengths less than unity, they are positively skew.

The practical use of these results requires very careful consideration and as it cannot be dealt with briefly, it will form the subject of a report to be published elsewhere.

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¹ Pierce, R. H., *J. Text. Inst.*, 17 (1926)

² Tippett, L. H. C., *Biometrika*, 17 (1925)

³ Sheppard, W. F., "B.A. Mathematical Tables", 7

Entropy of Saturated Liquid-Vapour Mixtures, and Trouton's Rule

It is well known that the entropy of a saturated vapour usually diminishes continually as the saturation temperature and pressure increase up to the critical values. On the other hand, the entropy of the saturated liquid increases continually. At any equilibrium below the critical, the vapour entropy S_v is greater than the critical entropy S_c , while the liquid entropy S_l is less. Thus it is possible to define a mixture of saturated liquid and vapour, say, of dryness q , such that the entropy of the mixture will be equal to the entropy at the critical point. The defining equation will be

$$(1-q)S_l + qS_v = S_c \quad (1)$$

For a number of substances, the value of q so defined varies but little over the whole range from the triple point to the critical point. Thus, for such substances, there is a particular mixture the entropy of which is approximately constant at the critical value. Table 1, obtained by examining tabulated data, shows mixtures the calculated entropies of which differ by no more than 10 per cent from the critical entropy over the whole range of available data, in some cases down to the freezing point, although the vapour and liquid entropies vary widely.

TABLE 1 MIXTURES GIVING APPROXIMATELY CONSTANT ENTROPY

Substance	CH_3Cl	$\text{C}_2\text{Cl}_2\text{F}_2$	CH_2Br_2	NH_3	CO_2	H_2O
q	0.63	0.89	0.29	0.554	0.61	0.50

Consideration of this circumstance has suggested the following discussion of a definable ideal case.

Since $S_v = S_l + \frac{L}{T}$, S_l can be eliminated from equation (1), to give

$$(1-q) \frac{L}{T} = S_v - S_c \quad (2)$$

Now let us imagine an ideal substance such that the equation for the entropy of a perfect gas is applicable to its saturated vapour right up to a critical condition, and also such that its mixture of dryness q has constant entropy equal to the critical value. Then substitution in equation (2) will give the following expression for its heat of vaporization

$$(1 - q) \frac{L}{Rt} = \frac{5}{2} \log \frac{t}{t_c} - \log \frac{p}{p_c} \quad (3)$$

Assuming that real substances may be considered to approach this ideal, we can substitute in equation (3) experimental values of boiling points and heats of evaporation at a given pressure, say, atmospheric, and the critical temperatures and pressures, and so calculate values of q (Table 2)

Substance	He	H ₂	N ₂	O ₂	HCl	Cl ₂	CO ₂	CS ₂
q	0.840	0.745	0.755	0.720	0.715	0.692	0.805	0.735
Substance	C ₆ H ₆	C ₆ H ₅ N	NO	NH ₃	C ₂ H ₅ OH	H ₂ O		
q	0.742	0.741	0.752	0.720	0.768	0.693		

It is immediately obvious from Table 2 that the values of q so calculated are nearly equal for all the substances. The average is 0.746, which is nearly equal to 0.75. This may be of significance, since it gives a whole number ratio, 3/1, of molecules in the vapour phase to molecules in the liquid phase.

Thus a number of real substances behave approximately in such a way that their heats of vaporization and boiling points at atmospheric pressure are related to their critical temperatures and pressures as would be those of an ideal substance having the perfect gas laws for its saturated vapour, and a constant entropy for its mixture containing 3 molecules of vapour to 1 of liquid. The 3/1 ratio may be related to the packing volume of spherical symmetry.

It will be clear that use of this idea, and consequently substituting $q = 0.75$ in equation (3), will predict values of $\frac{L}{t}$, so that the suggestion gives something corresponding to Trouton's rule. But Table 3, which compares experimental values of $\frac{L}{t}$ with values calculated on $q = 0.75$, shows it is more accurate than Trouton's rule.

TABLE 3

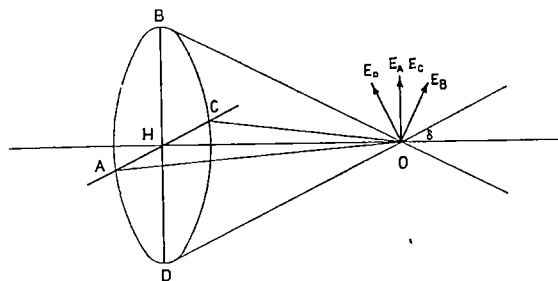
Substance	He	H ₂	N ₂	O ₂	HCl	Cl ₂	CO ₂	CS ₂
$\frac{L}{t}$ Expt	5.1	10.8	17.3	18.1	20.7	19.2	31	21
$\frac{L}{t}$ Calc	3.3	11.0	17.1	20.2	23.7	23.6	24.3	22.1
Substance	C ₆ H ₆	C ₆ H ₅ N	NO	NH ₃	C ₂ H ₅ OH	H ₂ O		
$\frac{L}{t}$ Expt	20.8	21.9	26.7	23.4	27.2	26.0		
$\frac{L}{t}$ Calc	21.5	22.7	26.5	26.2	25.2	32.0		

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Resolving Power of the Microscope using Polarized Light

In a recent paper¹ I derived formulæ expressing the distribution of light in the geometrical focal plane of optical systems of high relative aperture, and, using these formulæ, curves were given showing the distribution of light in directions perpendicular to, and parallel with, the direction of polarization for a system fulfilling the sine-condition, and of numerical aperture equal to 0.77. A conclusion drawn, on the basis of this work, was "The curves have bearing on the resolving power of microscopes. A variation of the resolution for two fixed points with rotation of the direction of polarization is suggested by them."



A paper has now come to my notice which confirms the existence of such a variation. In "An Application of Polarised Light to Resolution with the Compound Microscope"², Stump refers to a note in Carpenter's "The Microscope and its Revelations" (p. 325, 1891 edition) which records, as an unexplained fact, that by placing a Nicol analysing prism over the eyepiece "the effect [of resolution] is much strengthened". Stump examined a number of objects having minute periodic structure, and "it was found that in all cases where the prism was set so as to pass light vibrating in a plane parallel to the striæ being shown a clearer image was formed than when the prism was not used". This is fully in accord with the results I obtained mathematically, of which there seems possible a simple physical explanation.

In the diagram, HB is the direction of vibration of the light vectors in the incident plane-polarized wave, and $ABCD$ is an annulus of the emergent converging spherical wave. Elements of the wave passing through A, B, C, D proceed to the focus at O along the ray-paths AO, BO, CO, DO . At O the disturbances associated with A, B, C, D are E_A, E_B, E_C, E_D , of which E_A, E_C have full effect whereas E_D, E_B cancel along the direction HO , and along the direction of E_A, E_C have effective magnitudes $E_D \cos \delta$ and $E_B \cos \delta$, where δ is the angular semi-aperture of the annulus $ABCD$. Thus, relative to the meridian HC , the effective amplitude along HB is attenuated, and in the direction HC there is a greater concentration of energy in the outer part of the wave. This state of affairs leads to a narrower diameter of the Airy disk in the direction HC , and a (relatively) broader diameter in the direction HE . That is, striæ with their lengths in the direction HE will be better resolved than those along HC .

Evidently the resolution with the prism in its position of maximum effect will be greater than that using non-polarized light. This was found to be the case by Stump (*loc cit*): "a clearer image of the striæ was formed than when the prism was not used".

Stump attempted a very inadequate and tentative explanation of the phenomenon, and urged the use of as many separate beams as there were structural elements—claiming that the final image "would then be a composite, formed by the blending of several independent images, each showing some particular element in the structure". A photograph of the surface structure of *Amphipleura pellucida* is given in support of the claim.

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¹ *Proc. Phys. Soc.*, 55, 116 (1943).

² *J. Roy. Mic. Soc.*, 264 (1922).

BACTERIOSTATIC EFFECTS OF POTASSIUM CHLORATE ON SOIL NITRIFICATION

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IN the course of studies on the kinetics of soil nitrification, using our perfusion technique¹, we have observed a remarkable inhibitory effect of potassium chlorate on the conversion of ammonia into nitrate. We propose briefly to describe some of our main findings concerning the effects of chlorate on this important metabolic process in soil.

Technique

Our technique consists in perfusing a column of soil with oxygenated fluid by a circulatory process. The fluid, which contains in solution the substances the metabolism of which is being investigated, is made to percolate through the soil into a flask where it is mixed and aerated, and whence it is made to drain again through the same soil. The process is continuous and may be maintained for an indefinite period. The soil is left intact throughout the experiment and analyses are made only on the soil perfusate. The rate of perfusion is such that no water-logging of the soil takes place. The soil is well aerated and experiments in which oxygen is substituted for air have shown that aeration of the soil is, under our normal experimental conditions, optimal for nitrification.

The kinetics of metabolic events in the soil may be accurately studied by this technique, since it ensures constancy of oxygen supply and water content throughout the soil. The temperature is kept constant at 70° F by thermostatic control. Substances, the effects of which on the course of soil nitrification are being studied, can be added to the perfusion fluid at any time in the experimental period without handling or disturbance of the soil, and the subsequent rates of nitrification can be accurately measured.

The soil is, in fact, treated throughout the experiment as a biological whole, every effort being made to ensure constancy of the environment in which the soil is exercising its metabolic changes, except in so far as changes in the environment are brought about by the products of metabolism.

The soil is usually air-dried at room temperature and sieved. The fraction 4-1 mm is found convenient for perfusion purposes, and although any quantities may be used, depending upon the nature of the experiment, we have usually used 30-50 gm. in these studies.

Effects of Potassium Chlorate on the Velocities of Nitrite and Nitrate Formation in Soil

When ammonium sulphate solution is perfused through a soil, nitrification commences after an initial lag period, and nitrate accumulates until all the ammonia has been utilized. Traces of nitrite also appear in the early stages but disappear again as nitrification proceeds. When, however, a mixture

TABLE 1. INITIAL RATES OF NITRITE AND NITRATE FORMATION DURING PERFUSION OF 200 ML OF $N/100$ AMMONIUM SULPHATE SOLUTION THROUGH 30 GM OF AN ARABLE SOIL, IN THE PRESENCE AND ABSENCE OF POTASSIUM CHLORATE

Time in days from start of perfusion	Nitrite γ N/ml perfusate		Nitrate γ N/ml perfusate		Nitrite + Nitrate γ N/ml perfusate	
	In absence of $KClO_3$	In presence of $M/2000$ $KClO_3$	In absence of $KClO_3$	In presence of $M/2000$ $KClO_3$	In absence of $KClO_3$	In presence of $M/2000$ $KClO_3$
1	2	3	4	2	6	5
3	5	8	12	10	17	18
4	5	13	17	8	22	21
5	5	23	28	5	33	23
7	2	44	55	2	57	46

of ammonium sulphate and potassium chlorate is perfused through soil, nitrite accumulates instead of nitrate. The sum of the nitrite and nitrate, formed by the ammonia oxidized, is only slightly affected by the chlorate when this is used in relatively small concentrations. Typical results are shown in Table 1. They show that chlorate exercises a specific inhibitory influence on the conversion of nitrite into nitrate, and that the mechanisms concerned with the initial oxidation of ammonia are practically unaffected. The results also supply direct proof that oxidation of ammonia in soil to nitrate proceeds *via* the intermediate formation of nitrite. While few have seriously doubted that nitrite is an intermediate in this process, the evidence so far has been indirect and could not be regarded as supplying satisfactory proof of the essential intermediate role of nitrite.

Effects of Potassium Chlorate on Nitrite Oxidation in Soil

When sodium nitrite is perfused through soil, rapid oxidation to nitrate takes place after an initial lag period due presumably to the slow development of nitrite-oxidizing organisms in the soil. The presence of chlorate at so low a concentration as $M \times 10^{-6}$ markedly inhibits the process. Typical results are given in Table 2, which show that sensible inhibitory effects occur with $2.5 \times 10^{-6} M$ chlorate.

TABLE 2. RATES OF NITRITE OXIDATION ON PERFUSION OF 200 ML OF $M/280$ SODIUM NITRITE SOLUTION THROUGH 30 GM OF GARDEN SOIL IN THE PRESENCE AND ABSENCE OF POTASSIUM CHLORATE. INITIAL VALUE OF NITRITE $N = 333 \gamma$ /GM SOIL

Concentrat on of KClO ₃ added to perfusate	Time in days from start of perfusion										
	3	4	5	6	7	8	9	11			
	Percentage nitrite oxidized										
Nil	0	60.6	98.7								
2.5 × 10 ⁻⁶ M	0	43.2	71.7	95.4	98.1						
5.0 × 10 ⁻⁶ M	0	20.7	38.1	59.1	89.1	96.9					
10.0 × 10 ⁻⁶ M	0	22.2	35.1	50.4	57.6	65.7	76.8	96.0			

Effects of Potassium Chlorate, at Low Concentrations, on Ammonia Oxidation

Perfusion of ammonium sulphate through the soil in presence of very small concentrations of potassium chlorate has given results which show that although nitrite accumulates, it disappears in time. This disappearance is apparently not due to destruction of chlorate, because chemical and biological tests have indicated that chlorate is still present when nitrite oxidation has been completed. This phenomenon of nitrite accumulation is shown in Fig. 1. It will be observed (from Curves 4 and 5) that when relatively high concentrations of nitrite are formed, a long

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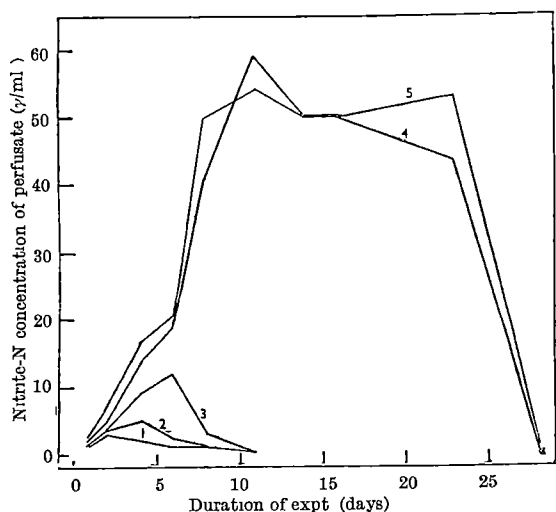


Fig 1 EFFECT OF POTASSIUM CHLORATE ON NITRIFICATION OF 200 ML $M/200$ AMMONIUM SULPHATE BY 30 GM OF ALLOTMENT SOIL. Conc of potassium chlorate present: Curves 1, nil, 2, $M/540,000$, 3, $M/180,000$, 4, $M/60,000$, 5, $M/20,000$

latent period of about fourteen days elapses before the nitrite disappears. After this period the rate of nitrite oxidation is normal. Since chlorate is still circulating at the end of the experiment, it follows that the oxidation of nitrite takes place in spite of the presence of the chlorate.

This result is consistent with the view that the chlorate does not markedly retard the actual chemical process of nitrite oxidation in the soil to nitrate, but rather that it inhibits the proliferation of those cells responsible for this oxidation. The initial burst of nitrite formation is due to the fact that the development of the ammonia-oxidizing organisms is unaffected by the chlorate, whereas that of the nitrite-oxidizing organisms is very greatly reduced. The latter do, however, develop slowly, presumably during the long latent period, until sufficient cells are produced to account for the final fast phase of nitrite oxidation.

It is, in fact, characteristic of the action of chlorate that it causes an initial lag, of variable duration, in

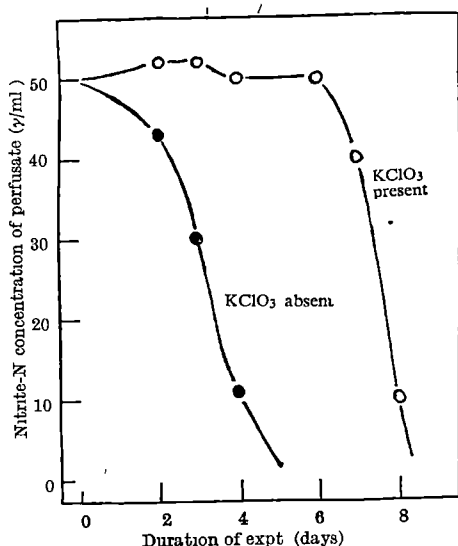


Fig. 2. NITRITE OXIDATION IN THE PRESENCE OF $M/10,000$ CHLORATE (FRESH SOIL)

the rate of oxidation of nitrite. This is seen in the results given in Fig 2, which show the rates of nitrite oxidation, in presence and absence of chlorate, on perfusion of $M/280$ sodium nitrite solution through soil. That the nitrite is completely oxidized to nitrate has been verified by analyses of the perfusion fluid. It is noteworthy that the rate of nitrite oxidation in presence of chlorate, after the initial long lag period, approximates to that obtained in the absence of chlorate.

Effects of Chlorate on a Soil Enriched with Nitrite-Oxidizing Organisms

If the view is correct that chlorate exercises its inhibitory effect largely by retarding the proliferation of nitrite-oxidizing organisms and not by poisoning the oxidative mechanism involved in nitrite utilization, it follows that chlorate should not prevent nitrite oxidation in a soil which has been enriched with the appropriate organism.

For experiment, soils were perfused with water alone and with sodium nitrite solution containing 50 γ of nitrite nitrogen per ml for four days (until the

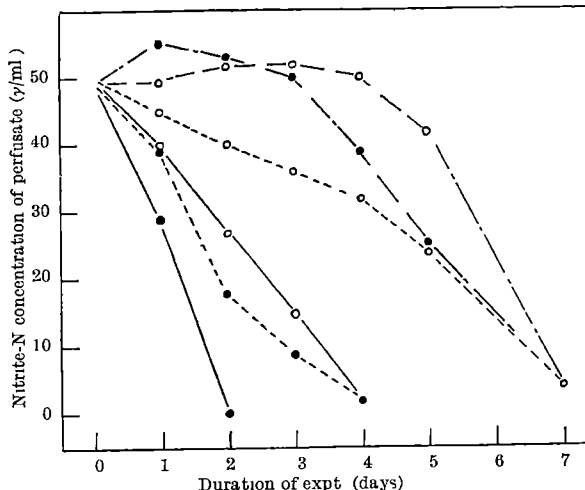


Fig 3 INITIAL PERFUSION ---, WATER, —, NITRITE, — —, CHLORATE SECOND PERFUSION ●, NITRITE ALONE, ○, NITRITE PLUS $M/10,000$ CHLORATE

nitrite was completely utilized). After this period the perfusion fluids were changed, the soils were thoroughly washed with water and re-perfused with fresh solutions of sodium nitrite, with and without the addition of potassium chlorate. The velocities of nitrite disappearance were measured and are shown in Fig 3. They show that chlorate exercises a small inhibition of the rate of nitrite oxidation in a previously nitrite-perfused soil, but that there is no initial lag period in the rate of nitrite disappearance. The same phenomenon occurs with soil previously perfused with water, though the subsequent rates of nitrite utilization are somewhat less. These results are consistent with the view that nitrite perfusion in a soil (in absence of chlorate) enriches it with nitrite-oxidizing organisms, which can then bring about their oxidations even in the presence of chlorate. Water perfusion of a soil results in a similar (though smaller) enrichment of these organisms owing to the fact either that traces of undecomposed nitrites are present in the soils, or that nitrite is being formed from the nitrogenous matter still in soil. A soil, however, initially perfused with chlorate (and cor-

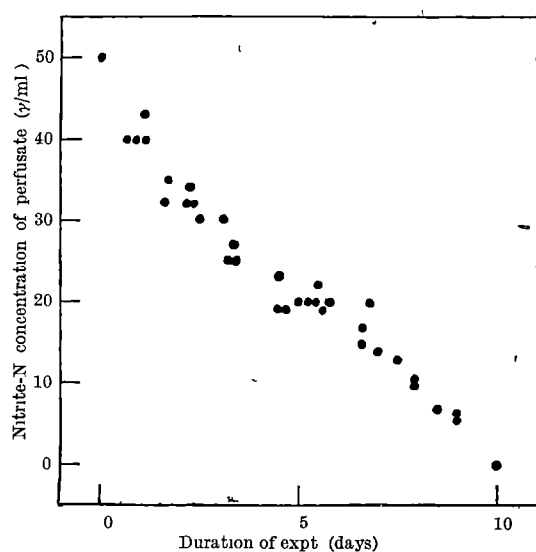


Fig 4 NITRITE OXIDATION IN THE PRESENCE OF CHLORATE (SOIL ENRICHED WITH NITRITE OXIDIZING ORGANISMS)

taining therefore but few nitrite-oxidizing organisms) shows on subsequent perfusion with nitrite a lengthy time lag before the nitrite undergoes oxidative change (see Fig 3).

Rate of Nitrite Oxidation in Soil in Presence of Chlorate

It would be expected that if the main effect of chlorate, at low concentrations, is to prevent proliferation of nitrite-oxidizing organisms, the velocity of nitrite oxidation in a soil enriched with these organisms would be a constant in the presence of chlorate. The velocity would be proportional to the number of cells initially present, it would not increase with time, in the presence of chlorate, as it should if proliferation were taking place.

The results of four separate experiments are included in the data given in Fig 4, in which the nitrite content of the perfusion fluid at any moment is plotted against time. The soils were enriched with nitrite-oxidizing organisms by initial perfusion with sodium nitrite, and then they were perfused with $M/280$ sodium nitrite solution containing potassium chlorate. Three concentrations of chlorate, $M/10,000$, $M/20,000$, $M/40,000$, were used, but much the same results were obtained with all three.

Fig 4 should be a straight line if the velocity of nitrite oxidation is constant. It will be seen that there is a close approximation to linearity, indicating the largely bacteriostatic action of chlorate.

TABLE 3 RATES OF NITRITE OXIDATION ON PERFUSION OF 200 ML $M/280$ SODIUM NITRITE CONTAINING $M/2000$ POTASSIUM CHLORATE THROUGH 50 GM GARDEN SOIL, IN THE PRESENCE AND ABSENCE OF NITRATES

Concentration of sodium nitrate added initially to perfusate	Time in days from start of perfusion									
	0	3	5	7	10	12	14	17	19	
	Nitrite N, y/ml perfusate									
Nil	50	54	51	55	55	56	52	52	50	
$M/400$	50	54	50	54	51	48	45	25	0	
$M/200$	50	53	50	50	48	45	36	14	0	
$M/100$	50	56	47	40	20	0				
$M/50$	50	39	29	20	0					

Effects of Nitrate on Chlorate Bacteriostasis

The action of chlorate in inhibiting the oxidation of nitrite in soil is partially or completely eliminated by the presence of nitrate. If a solution of sodium nitrite containing potassium chlorate is perfused through soil containing initially a relatively high concentration of nitrate, little or no retardation of nitrite oxidation is exhibited. Results given in Table 3 show how increasing concentrations of sodium nitrate in the perfusion fluid have increasingly large effects in neutralizing the action of chlorate.

This result demonstrates that nitrate alleviates the bacteriostatic effect of chlorate. The effect of nitrate is apparently specific, for no such alleviation is accomplished by phosphate, borate, chloride, sulphate, arsenate or *p*-aminobenzoate.

This phenomenon is possibly related to that described by Crafts² and by Hurd-Karrer³ in which nitrate reduces the toxicity of chlorate to plants.

Experiments are now being carried out to discover how nitrate exercises its neutralizing effects on chlorate inhibition.

Summary

Potassium chlorate at low concentrations ($c M \times 10^{-5}$ to $M \times 10^{-6}$) exercises a bacteriostatic action on soil organisms oxidizing nitrite to nitrate. The effect is specific, as chlorate at these concentrations has little or no effect on the conversion in soil of ammonia into nitrite. Chlorate administration to a nitrifying soil thus results in nitrite accumulation. Chlorate has little or no effect on nitrite oxidation in a soil which is rich in nitrite-oxidizing organisms. Its effect at low concentrations seems almost wholly concerned with the inhibition of the proliferation of these micro-organisms.

The bacteriostatic action of chlorate is specifically neutralized by the presence of nitrate, the alleviating action of which increases with its concentration.

¹ Lees and Quastel, *Chem and Ind*, 238 (1944)

² Crafts, *J Agric Res*, 58, 637 (1939)

³ Hurd-Karrer *Amer J Bot*, 28, 197 (1941)

WAR-TIME MEDICAL PROGRESS IN AMERICA

"ONE of the memorable experiences of this war," writes Prof D W Bronk, in his contribution to the symposium on war-time advances in medicine held by the American Philosophical Society (*Proc Amer Phil Soc*, 88, 151, 1944), "is to stand at evening in the Great Court of Trinity College, Cambridge, outside Isaac Newton's rooms, and watch the Flying Forts return." More memorable, some Cambridge residents might add, was the unforgettable sight, sudden and wonderful after dark years of trial, of the sky one summer evening full of the aeroplanes and men going out on the first one-thousand bomber attack. Such developments have been made possible by the work, in Great Britain and in the United States, of men like Prof Bronk, who is professor of biophysics at the University of Pennsylvania and co-ordinator of research, Office of the Air Surgeon, Headquarters Army Air Forces. His contribution to this symposium discusses such human problems of aviation as the effects of rising, as modern fliers do, to heights of six miles in six minutes, the effects of high-speed manoeuvres in machines built to withstand the stresses involved (although the human body is not) and problems of night flying and vision.

such problems could no doubt be classified under heading of environmental effects, and Colonel F Doriot, of the Quartermaster Corps, shows in other article how profoundly these affect the soldier and the sailor. He points out, also, that we are all concerned with protection from the environment. Clothing, he thinks, has been largely developed for the purpose of dressing the shop window and not for the particular tasks of the wearers. His discussion, illustrated by diagrams, of the problems posed by the clothing and equipment of the soldier and sailor, who have to operate in many different climates and have to be able to withstand rapid changes from one set of external conditions to other, has many applications to civilian life. The fighting man needs flexible clothing which is either warm or cool as the conditions demand. Colonel Doriot pleads for more technical education in the scientific principles of rational clothing than those engaged in the textile and clothing industries get at present, in this respect they compare unfavourably, he suggests, with a number of other industries. Fundamental researches are required. To neglect only one detail, Colonel Doriot rightly considers the problem of boots of great importance, and this point is also emphasized by Prof E A Strecker, of the University of Pennsylvania, in his article on neuropsychiatry. The foundations of morale, Prof Strecker says, are simple and obvious things, such as satisfactory living conditions, good, appetizing and well-cooked food, comfortable and nice-looking uniforms and, above all, easy-fitting shoes. Sport and diversion are also important. His discussion of war, which can, he says, no more be suppressed than the heart-beat can be stilled, is full of common sense. Important for those at home is his statement that morale fell when soldiers heard of strikes in the coal and other industries.

Another problem of the environment is discussed by Prof J L Gamble, of Harvard Medical School, in his article on the water requirements of castaways, a subject which has been much studied in Great Britain as well as in the United States (see, for example, MacDonald Critchley's Bradshaw Lecture on "Shipwreck Survivors" (London J and A Churchill, 1943) and the work sponsored by the Medical Research Council Committee on the Care of Shipwrecked Personnel). Assessing the water requirement during fasting with little or no physical activity at about 100 c.c., Prof Gamble describes experiments which indicate that at least 100 c.c. of this can be replaced by glucose or other food sugars or starches, with all the physiological advantages of this replacement, without disturbing the water balance. There was no appreciable water gain in subjects who drank 100 c.c. of sea water every day (3-4 litres would be needed to cover the daily water requirement of a castaway and even 500-600 c.c. would cause disturbing effects). In these subjects extracellular fluid volume was conserved by the gain from sea water and by increased withdrawal from intracellular water. Experiments done near Cape Cod in hot weather indicated that periodic immersion or wet clothing completely prevented loss of water above the basal rate. Solar radiation without a breeze caused loss of water at ten times the basal rate (more than 2 litres were thus lost by one subject, who, in six hours, thus wasted enough water to cover his intake need for three days). Shade, periodic immersion and wet clothing completely prevented this. Most impressive of all was the protection from water loss afforded

by a breeze (fortunately rarely absent). The castaway's great risk is therefore hot, windless weather.

Dr E J Cohn, of Harvard Medical School, contributes a valuable article on blood, blood derivatives and blood substitutes, with a bibliography of forty-eight references, mostly American. The contents of this paper can only be briefly indicated. It discusses plasma proteins, the dimensions in Angstrom units of these proteins and those of suggested blood substitutes, the equilibrium between the albumins and globulins of plasma and the tissues, the dissociation of the globulin molecules of plasma, the separation and concentration into fractions of the plasma albumins and globulins and their stability when separated. The article also discusses the use of gamma globulin antibodies for the prevention of measles and of iso-haemagglutinins in the typing of blood. The remarkable properties which the long, rod-shaped molecules of fibrin confer on fibrin films, made from fibrinogen and thrombin, are described. These films can be used as substitutes for the dura mater in neurosurgery of the brain. Their mechanical properties recall those of plastics, they can, for example, be stretched to twice or three times their original length or made into seamless tubing. Fibrin foam, made also from thrombin and human fibrinogen, may be, when it is dry, of two types. One type is light, fluffy and highly compressible, it wets easily, losing 90 per cent of its dry volume by shrinkage. The other type is dense, firm and less compressible, it wets slowly and then loses only about 50 per cent of its dry volume. Fibrin foam is used for stopping bleeding from veins or oozing surfaces, but not for stopping arterial haemorrhage, it is useful in neurosurgery. By appropriate control of their preparation, other types of fibrin-clot can be made, some of which are used in surgery or for skin-grafting.

Prof C S Keefer, of Boston University School of Medicine, deals with the use of penicillin in the treatment of various bacterial infections, and Prof A O Whipple, of Columbia University, also discusses this substance, together with others, in his article on recent advances in the treatment of wounds. R E Dyer, assistant surgeon-general, United States Public Health Service, writes about immunology. He directs attention to recent improvements in the immunizing potency of typhoid vaccine and the discovery and improvement of vaccines against yellow fever and typhus fever and of tetanus toxoid. Compulsory use of tetanus toxoid has removed the menace of tetanus from the United States military and naval forces, we are informed that tetanus is, for the same reason, no longer a menace to British fighting men. Further improvements in these and other immunizing procedures may be expected before long.

Perhaps the most thought-provoking article in the symposium is that contributed by Prof R J Dubos, the discoverer of gramicidin. Drug therapy, he argues—and many experienced observers will agree with him—constitutes only one facet of the complex problem of infection, and we should not be led away from these other aspects by the spectacular and popular appeal of recent chemotherapeutic achievements. Our difficulty is not to prepare more and more antibacterial substances, but to find out how they act in the body. They do not act as gross protoplasmic poisons, but selectively inhibit some vital process in the parasite's life. We need much more work on the problem of how they act.

There have been, on the other hand, important epidemiological and immunological advances towards

the control of such serious diseases as smallpox, yellow fever, diphtheria and infestations with such animal parasites as the hookworms and the schistosomes. We should study the host-parasite relationship much more, including micro-organisms among the parasites, and get away from the rather narrow channels into which the very rapidity of the success of serological and immunological research has directed investigation. The whole picture should be studied by resuming broad biological and biochemical studies of the host and its bacterial and animal parasites. So far as the bacteria are concerned, the study of the complex property of parasites which we call virulence is important. A given parasite can cause epidemics or disease only when it has been able (1) to reach a susceptible host, (2) to overcome the cellular and humoral defences of that host, (3) to multiply in it, and (4) to damage it. Each of these factors can vary independently of the others. In order to cause an epidemic, the parasite must possess them all at the same time. A highly pathogenic strain of hæmolytic streptococci, for example, may have only a low degree of communicability, and the converse may be true of other strains. The study of the resistance of the host is likewise very important, and there are other factors which the epidemiologist must consider. Prof. Dubos believes that we shall eventually be able to predict the course of epidemics and to organize 'listening posts' which will detect qualitative and quantitative changes in the number of infectious agents and in those of their properties which affect their virulence. A beginning in this direction has already been made.

It is a matter for conjecture, Prof. Dubos considers, whether preventive chemotherapy will ever become advisable or effective, but preventive immunological treatment can certainly be effective, as immunization against smallpox, typhoid, diphtheria and other diseases has shown. High degrees of immunity produced by means of killed bacterial cultures are, however, very specific and do not protect against related organisms of another immunological type, so that type-specific immunity protects against only the particular organisms concerned. For this reason, effective immunization of whole populations with type-specific vaccines may be impossible. It is, nevertheless, possible in some instances, for example, the pneumococci, to direct the immune response against a component of the bacterial cell which is common to all types of pneumococci. Possibly bacterial cell components will be found in all bacterial groups which can be attacked in this way, so that we may eventually be able to immunize against all the types of each group. The non-specific immunization of this kind which has so far been achieved is, however, lower than that produced by type-specific vaccines, but more research into it might enable us to raise its potency. We have hitherto studied type-specific immunization almost exclusively. Immunization techniques, moreover, have been up to now primitive in their principle of killing the pathogenic organism with heat or antiseptics. It is certain that a very large percentage of the material injected in anti-typhoid vaccination has no immunological value at all and even causes unfavourable reactions in those to whom it is given. It is very important to isolate the chemical components of the cell which do produce the immunity. If we could do this, we might, in the distant future, prepare artificially the substances required to produce the immunity.

G LAPAGE

ORGANIZATION OF INDUSTRIAL RESEARCH

FUTURE historians will no doubt record that opening decades of the twentieth century were characterized by the beginning of a systematic application of the results of scientific research to everyday life and the consequent foundation of research organizations, both large and small, mainly devoted to the best utilization of new knowledge in the service of commerce and industry. Moreover, these organizations, staffed by professional research workers together with technicians and other assistants in considerable numbers, stood out in striking contrast to the research conditions of the days of Faraday, Joule and Kelvin, when even advanced technological research was an entirely private venture. It is often forgotten to-day how young in years organized industrial research really is, and that while there are certain industries, such as heavy chemical and electrical engineering, which have expanded on a vast scale with laboratories widely distributed over Great Britain, there are also other industries, deeply rooted in history, having as yet no medium for the exploration of fresh ideas and wholly dependent on traditional techniques.

At a meeting of the London Branch of the Institute of Physics on February 17, Dr R. E. Slade, speaking from a wide practical experience, dealt with the factors which he regards as essential to the successful organization of research in the laboratories of manufacturing firms where most industrial research is now done.

Dr Slade began by pointing out that the laboratory must be a well-run unit constituting an integral part of the firm's activities and in full sympathy with the industry which it is trying to serve. Research is admittedly an individualistic operation, and its success is not a mere question of organization, though organization can facilitate the performance of the work, for this reason, the director or research manager should himself be an experienced researcher, able to inspire the workers under him, but suited to his methods to the personalities of the various section leaders. "There is room in every laboratory for a scientifically trained organizer to do the administrative work for the director, so as to relieve him of as much administrative work as possible." The ideal chemical research laboratory would thus consist of a director and an administrator with six section leaders, five having charge of researches and the sixth looking after services including the library, analytical department and workshop. Probably the most efficient size of industrial chemical laboratory would have six to a hundred university-trained workers and up to four hundred other workers. There is always a tendency for a laboratory to increase in size, but while it is cheaper to allow this rather than start a second new laboratory, it is not advisable to let the laboratory become so big that the director cannot know all his men and be prevented from exercising his personal influence and encouragement. "Not only do we want laboratories with distinctly different outlooks, but we want in each laboratory men with different kinds of training who will look at problems in different ways and tackle them in different ways too."

Dr Slade does not believe that the direction of a laboratory can be carried out effectively by a committee, he admitted the utility of advisory panels, but

phasized that the success of the laboratory depends upon the director being a research worker, capable of directing the laboratory, and having also the capacity of making a committee believe that it is directing the work when he is in reality leaving it to the common sense and ability of the section leaders. Moreover, if a company is to gain full value from its research department, there must be a director on the board of management who knows what research ought to do for it, and this director should himself have had research experience.

Industry must be alive to developments which may take place in any of the sciences, for example, the chemical industry needs to employ mathematicians, physicists, metallurgists and biologists. In regard to physicists, it would seem that they have not in the past been used to full advantage, for they have often been engaged as narrowly specialized technicians such as X-ray crystallographers and spectroscopists, instead of being given the opportunity of examining industrial problems in their entirety and so determining how best physical knowledge may be applied and what factor needs to be measured and to what degree. Similarly, the metallurgist should not be brought in, for example, when pipes have already corroded and broken down, but should be given the opportunity to see that industry has pipes that will stand up to manufacturing conditions.

One of the great problems of present-day industrial research lies in the difficulty of acquiring new specialized techniques as they appear. No laboratory is big enough to keep a specialist in every possible technique, and so workers have to be sent to the originator of the technique as students. This method is too slow for industry, and Dr Slade thinks that a national central laboratory of scientific techniques should be set up to serve industry in this field.

The cost of research is £1,500-£3,000 per annum per university-trained research worker employed, including assistants, mechanics, glass-blowers and services. Though high, the cost is fully justified by the results. Those carrying out research should have some authority to purchase equipment up to a reasonable sum, otherwise absurd cases will occur where men earning perhaps £600 a year or more are kept on unimportant work for weeks while a committee decides whether to spend £60 on a piece of apparatus.

Great importance should be attached to the linking of the research laboratory to the utilization of the products by the consumer, hence the director should learn to look at his problems from the point of view of the production manager and of the sales manager, and orient some of his researches accordingly.

After referring to the way in which the thirty research associations of Great Britain assist the special industries to which they are attached, Dr Slade then described in detail a method of linking research and industry, as carried out at the Mellon Institute in America, where manufacturers may have a specific piece of work carried out by endowing a fellowship for a number of years, in this way valuable work has been done on such diverse materials as limestone products, furs and their by-products, plastics, solvents, pesticides, rosins, high-boiling products, etc.

It is not in general desirable for university departments to carry out technological research, though industry has obtained its scientific outlook from the

men it has recruited from the universities, and while important discoveries may be made in industrial laboratories, we shall always be dependent upon the universities for the most fundamental work and for new ideas, so nothing should be permitted to limit this vital function of the universities.

Dr Slade concluded by stating that research thrives in an atmosphere of freedom, enthusiasm and achievement, and the aim of the organization of industrial research should be that of creating the best conditions for the individual workers with the view of applying knowledge and research to improve the arts of industry.

A particularly vigorous discussion followed the address, from which the following points, expressed perhaps in somewhat disjointed form, may be noted. Many good men are lost to research through promotion to administration. The researcher should have knowledge of what is practically possible in the craft of his industry, industry is suffering because problems are not being dealt with on a large enough scale, and there is need for co-operative research on a bold and comprehensive plan. Pooling of ideas will not result in lack of competition. A spirit of national service is requisite for industry in peace-time as well as in war-time. Workers should not be handicapped by having to write regular detailed reports of their work while it is in progress, but it is better to write a comprehensive report at the end. The cost of development and advertisement of results is bound to be relatively high in relation to the cost of the original research, it has therefore been suggested that exploratory research be limited by allocating, say, 20 per cent of research grants to original work and 80 per cent to development. The workshop is vital in research laboratories, and all workers should be able to carry out certain simple operations themselves and be able to make sketches of new apparatus, though very complicated drawings may be left to a draughtsman. Several speakers, including Dr Slade, deplored any suggestion that a central committee should decide what fundamental work each laboratory should undertake, though the opposite view was also expressed that in the interests of humanity some direction should be given as to what are socially desirable researches.

H LOWERY

FORTHCOMING EVENTS

(Meeting marked with an asterisk * is open to the public)

Saturday, March 3

GEOLOGISTS' ASSOCIATION (at the Geological Society of London, Burlington House, Piccadilly, London, W 1), at 2.30 p.m.—Annual General Meeting. Mr A. S. Kennard "The Early Digs in Kent's Hole, Torquay, and Mrs Cazalet" (Presidential Address).

Monday, March 5

ROYAL GEOGRAPHICAL SOCIETY (at Kensington Gore, South Kensington, London, S W 7), at 5 p.m.—Mr J. M. Wordie "North-West Greenland and North Baffin Island" (Kodachrome Film).

SOCIETY OF ENGINEERS (at the Geological Society, Burlington House, Piccadilly, London, W 1), at 5 p.m.—Mr D. Tiranti "The Need for Administrative Engineering".

ASSOCIATION OF AUSTRIAN ENGINEERS, CHEMISTS AND SCIENTIFIC WORKERS IN GREAT BRITAIN (at the Austrian Centre, 69 Eton Avenue, Hampstead, London, N W 3), at 7.45 p.m.—Mr E. A. Roth "Technical and Economic Problems of Post-War Agrarian Policy in Central Europe".

Tuesday, March 6

ROYAL ANTHROPOLOGICAL INSTITUTE (at 21 Bedford Square, London, W C 1), at 1.30 p.m.—Dr S. A. Huza'ayim "Further Light on the Upper Palaeolithic of Egypt".

ROYAL INSTITUTION (at 21 Albemarle Street, London, W 1), at 5.15 p.m.—Sir Henry Dale, O.M., Pres. R.S. "Nerve Endings and Chemical Transmitters", (1) "Actions of Involuntary Nerves and of Substances which Mimic or Paralyse their Effects".

INSTITUTE OF PHYSICS (ELECTRONICS GROUP) (in the small Physics Theatre, Imperial College of Science, Prince Consort Road, South Kensington, London, S W 7), at 5 30 p m—Prof. G. I. Finch, F.R.S. "Electron Diffraction"

SHEFFIELD METALLURGICAL ASSOCIATION (at 193 West Street, Sheffield 1), at 6 30 p m—Dr L. Northcott and Mr D. McLean "The Influence of Centrifugal Casting upon the Structure and Properties of Steel"

Wednesday, March 7

ROYAL SOCIETY OF ARTS (at John Adam Street, Adelphi, London, W C 2), at 1 45 p m—Mr R. F. Wilson "Colour as a Factor in Industrial Design"

ROYAL SOCIETY OF MEDICINE (at 1 Wimpole Street, London, W 1), at 2 30 p m—Mr Henry W. Robinson "Robert Hooke and the Importance of his Work in Medicine and Biology"

ROYAL ENTOMOLOGICAL SOCIETY OF LONDON (at 41 Queen's Gate, South Kensington, London, S W 7), at 3 30 p m—Dr W. E. Ripper "Recent Advances in the Control of Agricultural Pests"

INSTITUTION OF ELECTRICAL ENGINEERS (RADIO SECTION) (at Savoy Place, Victoria Embankment, London, W C 2), at 5 30 p m—Dr K. R. Sturley "Frequency Modulation"

Thursday, March 8

LINNEAN SOCIETY OF LONDON (joint meeting with the Zoological Society of London) (at Burlington House, Piccadilly, London, W 1), at 2 30 p m—Mr G. O. K. Sainsbury Photograph of a remarkable specimen of *Pseudopanax crassifolium* C. Koch—an Adult Tree with a Reversionary Shoot on the Trunk at 2 50 p m—Prof. J. McLean Thompson "The Study of Plant-Behaviourism: A Common Meeting-ground for future enquiries by Morphologists, Geneticists, Anatomists, Systematists and Physiologists Alike"

ROYAL INSTITUTION (at 21 Albemarle Street, London, W 1), at 5 15 p m—Sir Lawrence Bragg, F.R.S. "Some Physical Problems of the Solid State"

INSTITUTION OF ELECTRICAL ENGINEERS (INSTALLATIONS SECTION) (at Savoy Place, Victoria Embankment, London, W C 2), at 5 30 p m—Mr L. S. Atkinson "Modern Electric Lift Practice"

ROYAL AERONAUTICAL SOCIETY (at the Institution of Mechanical Engineers, Storey's Gate, St. James's Park, London, S W 1), at 6 30 p m—Mr C. G. Woodford "Electrics for Aircraft"

Friday, March 9

INSTITUTION OF MECHANICAL ENGINEERS (at Storey's Gate, St. James's Park, London, S W 1), at 10 30 a m—Conference on Surface Finish (A series of twelve Short Papers in five Groups: Group 1, Physical Aspects; Group 2, Methods of Measurement and Representation; Group 3, Considerations of Rational Specification and Requirement in Surface Finish; Group 4, Production Methods and Results of Modern Practice; Group 5, Effect of Surface Finish on Production)

SOCIETY OF PUBLIC ANALYSTS AND OTHER ANALYTICAL CHEMISTS (at the Chemical Society, Burlington House, Piccadilly, London, W 1), at 3 15 p m—Annual General Meeting, at 4 p m—Mr S. Ernest Melling "Water and Water Supplies" (Presidential Address)

ROYAL ASTRONOMICAL SOCIETY (at Burlington House, Piccadilly, London, W 1), at 4 30 p m—Scientific Papers

PHYSICAL SOCIETY (in the Physics Department of the Imperial College, Imperial Institute Road, South Kensington, London, S W 7), at 5 p m—Mr W. R. Ballard "The Formation of Metal-sprayed Deposits" Mr R. F. Bishop, Mr R. Hill and Prof. N. F. Mott, F.R.S. "The Theory of Indentation and Hardness Tests"

ROYAL INSTITUTION (at 21 Albemarle Street, London, W 1), at 5 p m—Prof. David Brunt, F.R.S. "Climate and Human Comfort"

Saturday, March 10

INSTITUTE OF PHYSICS (SOUTH WALES BRANCH) (in the Physics Department, University College, Swansea), at 2 30 p m—Inaugural Meeting Dr C. Sykes "Physics in Metallurgy"

APPOINTMENTS VACANT

APPLICATIONS are invited for the following appointments on or before the dates mentioned

BOROUGH ELECTRICAL ENGINEER—The Town Clerk, Municipal Offices, Town Hall Street, Blackpool (endorsed 'Borough Electrical Engineer') (March 10)

ASSISTANT TEACHER OF MATHEMATICS at the School of Building, East Ham Technical College—The Chief Education Officer, Education Department (T), Town Hall Annex, Barking Road, East Ham, London, E 6 (March 10)

RESEARCH ENGINEER immediately to organize and control Laboratory and Experimental Department of progressive manufacturing company situated in N.W. London area—The Ministry of Labour and National Service, Appointments Department, Central (T and S) Register, Room 5/17, Sardinia Street, Kingsway, London, W C 2 (quoting Reference No. C 2482 XA) (March 12)

FOOD AND DRUG ANALYST for service with large Company operating in the Middle East—The Ministry of Labour and National Service, Appointments Department, Central (T and S) Register, Room 5/17, Sardinia Street, Kingsway, London, W C 2 (quoting Reference No. F 2894 XA) (March 12)

TEACHER OF ELECTRICAL ENGINEERING SUBJECTS, a TEACHER OF MECHANICAL ENGINEERING SUBJECTS, a TEACHER OF MATHEMATICS, and a TEACHER OF CHEMISTRY (to teach PHYSICAL and INORGANIC CHEMISTRY to Honours Degree standard)—The Principal, Acton Technical College, High Street, Acton, London, W 3 (March 12)

SENIOR (Reference No. C 2485 A) and JUNIOR (Reference No. C 2486 A) ENGINEERS (mechanical and electrical) to carry out work of national importance in a Government Department (location London)—The Ministry of Labour and National Service, Appointments Department, Central (T and S) Register, Room 5/17, Sardinia Street, Kingsway, London, W C 2 (quoting the appropriate Reference No. (March 16)

SUPERVISORS (PRODUCTION ENGINEERS, 3) for TELEGRAPH WORKSHOPS at Calcutta, Jubbulpore and Bombay, for manufacture of stor connected with Telecommunication Development—The Ministry of Labour and National Service, Appointments Department, Central (T and S) Register, Room 5/17, Sardinia Street, Kingsway, London, W C 2 (quoting Reference No. C 2484 A) (March 17)

ADDITIONAL OFFICER for Secretarial and Organizing work (applicant should be chemists with organizing and administrative ability)—The Hon. Secretary and Registrar, British Association of Chemists, 1, Piccadilly, London, W 1 (endorsed 'Additional Officer') (March 31)

GARDEN STEWARD (woman) with responsibility for the upkeep of about 50 acres of gardens and grounds—The Secretary, Girton College Cambridge (April 10)

MALE TECHNICIAN, with some knowledge of section cutting and staining, for Anatomy Department—The Secretary, Medical School St. Thomas's Hospital, London, S E 1

EDUCATIONAL PSYCHOLOGIST—The Director of Education, County Hall, Kendal, Westmorland

GRADUATE IN BIOLOGY (candidates must be able to teach CHEMISTRY and PHYSICS in relation to BIOLOGY and HYGIENE) at the Folkestone Day Technical School for Girls—The District Secretary, Kent Education Committee, at the Technical Institute, Ashford, Kent

REPORTS and other PUBLICATIONS

(not included in the monthly Books Supplement)

Great Britain and Ireland

Department of Scientific and Industrial Research Tyroglipic Mites in Stored Products, 1 A Survey of Published Information Supplement 1944 By M. E. Solomon Pp 8 (London H.M. Stationery Office, 1944) 2d net

Royal College of Physicians of London Social and Preventive Medicine Committee Second Interim Report, January 1945 Industrial Medicine Pp 24 (London Royal College of Physicians 1945)

Imperial Bureau of Animal Health Review Series, No. 2 Models of Spread of *Streptococcus agalactiae* Infection in Dairy Herds, a Report on Co-ordinated Observations organised by the Agricultural Research Council of the United Kingdom Pp iii+27 (Weybridge Imperial Bureau of Animal Health, 1944) 3s

Monographs of the Quekett Microscopical Club The Discovery of the Uses of Colouring Agents in Biological Micro-Technique By Dr John R. Baker Pp 22 (London Williams and Norgate, Ltd, 1945) 1s 6d

British Rubber Producers' Research Association Publication No. 55 The Structure of Polyisoprenes, Part 2 The Structure of β -Guttapercha By G. A. Jeffrey Pp 4 (London British Rubber Producers' Research Association, 1944)

Hannah Dairy Research Institute List of Publications, 1928-1944 Pp 16 (Ayr Hannah Dairy Research Institute, 1944)

British Electrical and Allied Industries Research Association Twenty-fourth Annual Report, October 1st, 1943, to September 30th, 1944 Pp 127 (London British Electrical and Allied Industries Research Association, 1945)

Other Countries

Commonwealth of Australia Council for Scientific and Industrial Research Bulletin No. 180 Studies on Deglutition in Sheep 1 Observations on the Course taken by Liquids through the Stomach of the Sheep at Various Ages from Birth to Maturity, by R. H. Watson, 2 Observations on the Influence of Copper Salts on the Course taken by Liquids into the Stomach of the Sheep, by R. H. Watson and I. G. Jarrett Pp 126+7 plates Bulletin No. 181 Sheep Blowfly Investigations—The Attractiveness of Sheep for *Lucilia cuprina* By I. M. Mackerras and M. J. Mackerras Pp 44+2 plates (Melbourne Government Printer, 1944)

Government of Travancore Administration Report of the Government Museum for the Year 1118 M.E. Pp 8 (Trivandrum Government Press, 1944)

South Australia Department of Mines Mining Review for the Half-Year ended 31st December 1940 (No. 73) Pp 96 Mining Review for the Half-Year ended 30th June 1941 (No. 74) Pp 56 Mining Review for the Half-Year ended 30th June 1942 (No. 75) Pp 95 Mining Review for the Half-Year ended 31st December 1942 (No. 77) Pp 81 Mining Review for the Half-Year ended 30th June 1943 (No. 78) Pp 138 Mining Review for the Half-Year ended 31st December 1943 (No. 79) Pp 128 (Adelaide Government Printer, 1941-1944)

South Australia Department of Mines Geological Survey of South Australia, Bulletin No. 19 The Underground Water of the South-Eastern Part of South Australia By Dr L. Keith Ward Pp 56 Bulletin No. 20 The Structural Control of Ore Deposition in some South Australian Copper Fields No. 1 A The Wallaroo-Mounta Field, B The Dome Rock Copper Mine, C The Mount Gunson-Pernatry Lagoon District, D The Burra Burra Mine, E The Callington-Mantoo District By S. B. Dickinson Pp 99 Bulletin No. 21 The Structural Control of Ore Deposition in some South Australian Copper Fields No. 2 F Kapunda Mines, G Bhamra Mine, H Sliding Rock Mine, I Lady Lehmann Mine By S. B. Dickinson Pp 6 (Adelaide Government Printer, 1941-1944)

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REHABILITATION OF EUROPEAN CULTURE

THE encouraging measure of agreement reached by Mr Winston Churchill, President Roosevelt and Marshal Stalin at the Yalta meeting, as indicated in the communique issued on February 12, goes far to offset some of the doubts as to common policy which have arisen since the tentative proposals of the Dumbarton Oaks Conference were issued last October. Agreement has been reached on the difficult question of voting procedure in the Security Council of the new peace organization, and a Conference of the United Nations is to be called to meet at San Francisco on April 25, 1945, to prepare the charter of such an organization along the lines proposed at Dumbarton Oaks.

The declaration on liberated Europe is the most important of the three parts into which, apart from the military plans, the statement falls naturally. It is true that European policy cannot be sharply separated from the treatment of Germany, but without some common European policy and without the reconstruction of civil life and the full restoration of social, economic and cultural activity, in which science has a prominent place along with other intellectual activities, there can be no hope of any adequate solution of the German problem.

That problem will probably provide the most searching if not necessarily the first test of the adequacy of any new world organization, and it is the appearance of lack of harmony in the policy of Great Britain, of the United States and of the U.S.S.R. towards the liberated countries of Europe during the last six months, that has given such a shock to public opinion. The three Governments—and the statement expresses the hope that the provisional Government of the French Republic may be associated with the three Powers in the procedure suggested—declare their mutual agreement to concert their policies, during the temporary period of instability in liberated Europe, in assisting the peoples of Europe to solve by democratic means their pressing political and economic problems. The establishment of order in Europe and the rebuilding of national economic life must be achieved by processes which will enable the liberated peoples to destroy the last vestiges of Nazism and Fascism and to create democratic institutions of their own choice. To foster the conditions in which the liberated peoples may exercise their sovereign rights and self-government, the three Governments pledge themselves to give joint assistance where required, in their judgment, to establish conditions of peace; to carry out emergency measures for the relief of distressed peoples, to form interim Government authorities broadly representative of all democratic elements in the population and pledged to the earliest possible establishment through free elections of Governments responsive to the will of the people, and to facilitate, where necessary, the holding of such elections.

The declaration, which provides for consultation

with the other United Nations in Europe when matters of direct interest to themselves are under consideration, thus proposes to proceed from world order to peace, and though it may be objected that there are areas in Europe which are not yet ripe for democratic institutions, over a large part of liberated Europe this implementation of democracy should be effective and appropriate. Further, the second proposal—emergency measures for the relief of distressed peoples—is one that may well at once provide an effective means of education in democratic methods and the touchstone of the sincerity and determination of the three Great Powers subscribing to the Yalta Declaration.

There is in fact no question touched upon during the recent conference that is of more immediate concern to Great Britain than that of relief for the liberated countries of Europe. Grave anxiety regarding the relief of France has already found expression in the House of Commons and in the Press, and has not been dispelled by either Mr. C. R. Attlee's statement or the more recent one of Mr. Richard Law. The concern is shared by the troops serving on the Continent, and on all sides there is evidence that a more generous, imaginative and positive policy would be welcomed, and indeed is essential if the goodwill we found on the Continent is not to run to seed. The criticism of, and charges of grave weaknesses in, the United Nations Relief and Rehabilitation Administration which Dr. H. V. Evatt, leader of the Australian delegation, uttered at the opening session of the Conference of that body at Lapstone are in keeping with growing uneasiness which has been apparent since its council met at Montreal in September.

Much of the criticism that has been levelled against the United Nations Relief and Rehabilitation Administration may in fact be unjustified, for since the first session of its council met at Atlantic City in November 1943, a large organization has been built up and much information gathered about the needs to be met and the supplies available to meet them. So far, however, the actual relief work in the liberated areas of Western Europe has been done by the military authorities in conjunction with the French and Belgian Governments. Dr. Evatt argued from this that it was doubtful whether the Administration would perform all the duties intended under the terms of its charter, and urged that there must not be the same delays in the Far East that have occurred in Europe. Further, he said that administration was over-centralized and that wider national representation was needed at all levels of the administration and staff.

It is expected that U.N.R.R.A. may shortly be allowed to send supplementary supplies to certain countries; such as France, Belgium and Holland. This will involve a complete departure from the general principle of that body, that it will not operate in a country until invited to do so by the Government in power, and, in Western European countries who wish to pay for their supplies, until the relevant financial negotiations have been completed. While

the new proposal releases the organization from the strictures that have in the past prevented it from dealing promptly with emergencies, it in no way affects the general schemes for providing relief in bulk in accordance with the original terms of the charter.

Though it is clearly unfair to blame U.N.R.R.A. itself for the present position, even given the limitations on its activities imposed by its charter, public opinion is not disposed to hold the Government entirely free from blame in this matter. Mr. Richard Law's statement in the House of Commons on February 13 with reference to relief appeals for allied and liberated countries will not allay misgivings on this point, for it showed lack of insight and imagination. His statement on February 14 on the economic and supply position in the liberated countries of Western Europe, while satisfactory so far as it went, did not remove the impression that the military authorities, to whom the matter had been left, have not shown sufficient foresight. The main failure, Mr. Law said, has been in distribution, but the national governments cannot be held entirely responsible because not only were the means of transport lacking but also the administrative machine had become seriously impaired and had to be rebuilt. No one will deny that the first objective of the military authorities must be to wage war and to wage war effectively, or that the requirements of our liberated allies are in direct competition with urgent military demands. Equally it cannot be denied that the position is one where high policy is also involved, and where the Government cannot evade the responsibility for rapid and decisive action.

What appear to be lacking are the imagination and warmth of sympathy already evident in public opinion. There is in the Government's statements no appreciation of what might be the effect of announcing that we were to release, for example, some of our own ample stocks of fats for France and Belgium, where the deficiency is so great. It is not yet forgotten in Europe that Mr. Churchill, when Secretary of State for War in 1919, not only opposed the continuance of the blockade of Central Europe as endangering a collapse of the entire structure of German social and national life, but also had earlier sought on Armistice Day to send six food ships to Hamburg. It is all a matter of the right priorities. We have large reserves of many other foodstuffs which were regarded as essential when the climax of the War still seemed distant but which could be safely reduced now. Even a reduction of food rations in Britain might be considered for the critical few weeks, provided that the urgency were explained fully to the people.

What is most essential is a clear understanding of how dangerous the alienation of France may become, and of how urgent it is not merely to meet the need but also to seize the chance to restore France. When that is realized there can be no hesitation over the decisions to be taken to divert transport from the more obvious military needs to the more urgent but no less vital needs of the political and economic

warfare against the same enemy. Here, as throughout the War, has been the weakest spot in our strategy, the rapid reconstruction of Europe is in fact not merely the background against which all relief work, whether through the United Nations Relief and Rehabilitation Administration or not, should be viewed, but also an essential condition of victory, without which military success may be sterile.

Nor should it be imagined that relief and reconstruction have physical or material aspects alone. The reconstruction of France and of Europe is a cultural and spiritual task also. Even now, six months or more after the liberation of France and Belgium, cultural contacts have scarcely been established except in the most desultory manner. Import of French books has not yet been resumed, and the Government's own policy with regard to paper for books removes all hope at present of providing France with the British scientific and other books which she awaits. Without such interchange and collaboration there cannot come the full understanding between the two great Western democracies which must be a prelude to their closer co-operation in the reconstruction of Europe, in whatever form that may ultimately take.

The abatement of national prejudice and passion, and the mutual sacrifices which are involved in building any form of world order, will not be made in moments of sentimental impulse. They will arise out of a clear understanding of what is involved and the deliberate surrender of the lesser to the greater ideal. That is the substance of Prof. D. Mitrany's argument in "The Road to Security"*. He sees the only basis of security in positive and constructive action in the social and economic fields. An international organization cannot limit itself to the negative purpose of restraining aggression in a world of change; it must also help to bring about constructive change.

Prof. Mitrany, in this little pamphlet, brings out very clearly the relation between national planning and world order. International peace cannot be considered as consisting only in the prevention of violence. We must take account of social unity and economic development, and it was the failure to do this that broke the system of common order represented by the League of Nations. If once more we conceive of security as merely a matter of policing the world against the use of violence, we may well find divisions in the economic world—competition in shipping and aviation, for raw materials and trade—even more acute than during the twenty years of truce. Even the aspirations for full employment and social security, with the national planning and State action involved, may threaten security unless national planning is geared from the outset to international planning.

In fact, the organization envisaged at Dumbarton Oaks will be futile, Prof. Mitrany believes, unless we develop joint economic arrangements sufficiently

comprehensive and far-reaching to prevent a split between the participating Powers. Such arrangements would go far towards protecting States, especially the economically weak States, from economic aggression, and remove the temptation to try aggression for economic and social ends. Moreover, certain agencies are already available for that purpose, as Prof. Mitrany points out, and as is further indicated in the P.E.P. broadsheets which have been brought together and re-issued under the title "Building Peace out of War". Economic technical agencies would be preventive, by their very nature, in a way in which military agencies never can be. Just as it would be their function to give service wherever it is needed, so it would be their duty to deny service where it is not obviously needed and might be abused.

Stress is laid by Prof. Mitrany on this withdrawal of services as an effective form of sanctions, but the most important point is undoubtedly that they are a step towards dealing jointly and resolutely with the very springs of war. The real problem of security and the task of statesmanship are not to keep the nations peacefully apart, but to bring them actively together, and in such a task science has an essential part to play. As is pointed out in the P.E.P. broadsheets, in building European unity, parallel with the establishment of a framework of order and security must go the reconstruction and development of European life in the direction of a social, economic and cultural community which all its citizens have a common interest in maintaining and furthering, and to which all will eventually come to feel a loyalty commensurate with their loyalty to their own countries. Moreover, the key to the restoration of social stability will be the rebuilding and development in new forms of those cultural and other institutions and associations which are the life-blood of a free community, but have been persecuted or suppressed by totalitarian Germany—universities, churches, trade unions, professional organizations, the free Press and radio.

Linked with the rebuilding of institutions is the gradual development of individual leaders in every sphere, and here the emphasis must be on individuals, not governments, for in a Europe functioning as a community the individual leaders of industries, trade unions, universities and other vital institutions are as important as those of regional governments. In such a process the universities of Europe, which inherit the tradition of European unity, must take a central role, whether or not there is linked to them, as is suggested by P.E.P., as centres of post-graduate training and research, one or more special European staff colleges for the training of Europe's key administrative personnel.

There can be no doubt that, as is stated in the final study of this volume, the people of war-ravaged Europe will look to Britain for help and guidance in picking up again the scattered threads of the European tradition, and in rebuilding the institutions in which it is largely embedded. But since that broadsheet was written in 1943, the problem and the task have

* *The Road to Security*. By Prof. David Mitrany. Pp. 20. (Nat. Peace Council, 144 Southampton Row, London, W.C.1, 1944.) 4d.

become urgent and imperative. The situation is desperate, and it is no longer merely a matter of urging that the advance of science demands the resumption of normal free communication and contact the moment military exigencies permit. It is rather that unless the physical task of relief and reconstruction is undertaken forthwith, military success may be sterile. Even now the physical task demands all the help and inspiration it can draw from the cultural life and the institutions which enshrine the tradition of European unity and the highest ideals of its intellectual and spiritual life.

It is in fact a moral obligation that rests on scientific workers to press for the re-establishment of contacts with their colleagues in liberated Europe, and to co-operate with them in building up once more the tradition and institutions of learning and research which Germany has sought to extirpate. The task of reconstructing the universities of Europe is immense, and in the physical sphere little may yet be practicable. But already the planning of such reconstruction is an urgent task, and a generous response to the desperate needs of Europe on the part of scientific workers, no less than of other men of learning and culture, might have an immense effect in establishing an atmosphere of understanding and goodwill and in giving new hope. What are required above all are vision and imagination to sense the possibilities, as well as the dangers, and to grasp the significance of the European cultural contacts and institutions which the Committee on Intellectual Co-operation once represented, not merely in providing the leaders required to-morrow, or in establishing the freedom of thought, of utterance and of investigation, but in creating that sense of European community of interest, of confidence, which brings fresh hope, in place of frustration or despair, and without which the sore-pressed peoples of Europe might have no heart to address themselves to that task of reconstruction.

BOTANY IN BRITAIN

British Botanists

By John Gilmour (Britain in Pictures Series)
Pp 48+8 plates (London: Wm Collins, Sons and Co., Ltd., 1944) 4s 6d net

THE history of science has for so long been written from the point of view of chemistry and physics, with generous recognition of astronomy and even geology, but with almost complete indifference to biology in any form, that it is encouraging to note the recent development of interest in the records of early botanists and zoologists. A brief and accurate history of British botany, written with the knowledge that the late Dr. Gunther on one side and Dr. Agnes Arber on the other have made available to us, is a very valuable help to such development. Mr. John Gilmour's book is excellent and timely.

To survey a history which covers four such changeful centuries, to tell the story of so large and so varied a succession of students, to keep a sense of proportion so that the outstanding developments of the science are not lost in a mass of detail, and to present the story with all its human interest and

charm and excitement as a fascinating adventure, this fourfold task Mr. Gilmour has discharged with eminent success. There are inevitably gaps, particularly perhaps in the early stages of the story: the present reviewer would plead for recognition of Thomas Penny, the friend of De l'Obel and De l'Ecluse and chief author of the "Theatrum Insectorum", and of Thomas Willisel, the first professional field-naturalist, employed by Merret and then by the Royal Society, and the discoverer of many of our rarer plants, particularly in the Pennines and Teesdale. But to compress the record into forty-eight pages, many of them half-filled with pictures, is necessarily to cut it down to the barest skeleton. That Mr. Gilmour has nevertheless found room for such delightful descriptions as that of Stephen Hales' Sunday at Teddington and for clear hints as to the relationship between botanical studies and the general ideas and culture of the time is proof of real skill as a writer as well as of real knowledge as a historian. We notice only one slip in matter of fact: Bilson, not Bilster, is the name of John Goodyer's employer on p. 13.

The book, like others of the series, is almost lavishly illustrated, and here too Mr. Gilmour has chosen his pictures with discrimination. They cover a very wide range of subjects, are representative of different aspects and moments of the story, and thus are a real contribution to the record.

It is much to be hoped that Mr. Gilmour will carry on with work in this field. There is no satisfactory history of botany, and few subjects supply more abundant and more interesting material. He has evidently got a thorough knowledge of very much of what is generally available, and possesses the threefold qualification—a thorough knowledge of botany, an understanding of historical method and research, and the power to write vividly and accurately. We hope that the success of this small essay will encourage him to a large-scale work.

C. E. RAVEN

REJUVENATION OF PLANT GEOGRAPHY

Foundations of Plant Geography

By Prof. Stanley A. Cam. Pp. xiv+556 (New York and London: Harper and Brothers, 1944) 5 dollars

IN a recent review of "Historical Plant Geography" by the late Prof. E. V. Wulff¹, reasons were given for thinking that the subject had been revitalized by the recent application to it of methods and information developed and acquired in other scientific fields. It now appears that while these changes were leading Prof. Wulff to write his book in Leningrad, they had, in the United States, caused Dr. S. A. Cam similarly to set about accumulating material for this comprehensive volume on "Foundations of Plant Geography".

Though both works convey the indication of the opening of a wide territory for scientific investigation, they differ considerably in scope and emphasis. Prof. Cam's book is conspicuous for its reference to a very large body of work by the great American phytogeographers, such as Asa Gray, Fernald, Marie Victorin and Gleason, with their very numerous and able followers. One cannot indeed help the reflexion that the North American continent has offered, and still does offer, greater advantages to the plant

geographer than any other continental area. The circumstance was long ago pointed out that the mountain-range direction from north to south did not hinder the great vegetational movements made under compulsion of the climatic shifts of the Ice Age, and there now persists a tremendously rich flora distributed in patterns the meaning of which we at last begin to glimpse.

Among the most striking resolutions achieved so far we may mention (1) the per-glacial survival of species described by Fernald in the Gaspé peninsula and equivalent areas, (2) the work of Miss Lucy M. Braun to demonstrate the preservation of Tertiary mixed forest in the southern Appalachians, and the differentiation and migration of later vegetation types therefrom, (3) the history of migration and evolution of the genus *Vernonia* in the south and east of the United States worked out by Gleason, and (4) the remarkable history of western American forest types established by Chaney and Mason from fossil and distributional evidence throughout the Cenozoic period.

Nowhere has the study of genetics and its application to the problems of the mechanism of speciation been given more enthusiastic attention than in the United States, and Dr Cam's book is characterized (in contrast with that of Prof Wulff) by a sustained attempt to clarify the relation between modern cytogenetics, evolutionary theory and problems of plant distribution, indeed, about half the book is occupied by discussion of topics in this field. It is evident that the phenomena of speciation are so distinctly concerned with genetic isolation, which itself is closely correlated with geographic isolation, that progress in knowledge of evolution and of phyto-geography alike demands an increasingly critical investigation of the distributional data of plant populations. The recognition of this situation makes great demands (as it presents great opportunities) to the modern plant geographer. He may not assume that the 'species' of taxonomists, his chief working material, are by any means equivalent in status or origin, he must not assume that the first-described species type is necessarily the basic form from which later-described varieties are derivative, and he must always be prepared to submit his collected material to intensive genetic and cytological analysis.

The way in which Dr. Cam attempts to integrate the cytogenetic approach with recent knowledge of geological and climatic history can be illustrated by a quotation (p 432) "In such a region, especially after glacial recession has commenced, there are numerous new, variable and closely associated habitats in which populations of a variety of species can live in rather close proximity. The result of this intermingling of species may be the production of hybrids, followed sometimes by amphidiploidy. With continued glacial recession, the polyploids and backcrosses are in a position to expand their area tremendously. Some of the diploids also may extend far on to the glacial plain, but most of them will probably have only limited expansion. The chances of such polyploids spreading into unglaciated territory to any considerable extent seems unlikely because penetration of closed communities is more difficult."

The reality of such a mechanism as this remains to be established, like that of so many hypotheses for similar distributional and evolutionary situations; but it will be apparent how usefully the book directs attention to the considerable progress recently made in definition of problems and recognition of new approaches.

We may note a few incidental features of general interest which indicate the progress of phyto-geographic ideas in the last decade or two. General opinion is shown to have swung over (partly as a result of the teaching of Willis) from regarding endemics as relict, to regarding them in many instances as recently evolved, it is now said that "some geographers believe in the efficacy of long-distance dispersal for many types of organisms, but the weight of evidence in most cases seems to be strongly opposed to such an assumption"; centres of preservation of plants throughout the ice age are freely accepted to have occurred even in northern territories.

Prof Cam is well aware that in attempting to synthesize the results of many sciences he lays himself open to attack from the specialists in all of them. We shall here only give a single general and constructive criticism. It is stressed that there is necessity for migration of biotypes into new areas if there is to be reasonable chance for new ecotypes to arise. Geographers and ecologists may easily overlook that the habitat may, so to say, migrate to the species, rather than the other way round. By this I mean that we should view plant populations, not as living under stable conditions, but against a background pattern of ceaseless climatic change, with small seasonal shifts at one end of the scale of frequency and amplitude, and glacial epochs at the other. Especially if this alteration affects a topographically varied territory, there is then little need to invoke migration to precede the differentiation of ecotypes.

The section headings will convey the content of the book (1) Introduction, (2) Palaeoecology, (3) Areogeography (that is, distribution patterns), (4) Evolution and Plant Geography, (5) Significance of Polyploidy in Plant Geography. There are an immense bibliography and a useful glossary.

H. GODWIN.

¹ *Nature*, 152, 490 (1943)

MEASUREMENT OF COLOUR

The Measurement of Colour

By Dr W. D. Wright Pp vii+223. (London: Adam Hilger, Ltd, 1944) 30s. net.

A BOOK by Dr W. D. Wright may confidently be expected to be first class, and the present publication is ample justification for such a prophecy. Colorimetry depends mainly upon classical physics for most of its theory, and luckily the conceptions involved are to some extent quasi-mechanical, which is probably the reason why applications to industry and technology have been both rapid and successful. The reviewer's task may thus best be implemented by discussing some of the more important of these developments in the light of the guidance afforded by the volume before us. Before so doing, however, there are a few features of wider significance. One is the way in which the fundamental character of certain optical instruments and processes is laid bare; for example, the additive trichromatic colorimeter, the photo-electric tricolorimeter and the three-colour process of colour reproduction. The reader can see from the diagrams exactly what functions must be fulfilled, unmolested by photographs or descriptions of particular types of apparatus. Incidentally, what searching examination questions these topics would provide to describe simply and directly the necessary and sufficient conditions that the required ends

(often very involved) may be achieved. It would certainly not be easy to do it better than it is done here. Something of the kind found a place in the best German books of the nineteen-twenties, but they lacked the stimulus to deep comprehension on the reader's part which Dr Wright has managed to introduce.

Another question treated with unusual clarity is that of the human retina, especially from the point of view of Polyak's work (1941). This leads naturally to a comparison of the wave-length and relative luminosity positions of the scotopic (low brightness) and photopic (high brightness) curves, the former for rod (monochrome) vision, and the latter for cone (coloured) vision. Artists and the like are well aware, empirically, of the darkening of red surfaces with diminishing illumination, a species of Purkinje effect for which the relative displacement of the scotopic curve towards higher frequencies is responsible. Although perhaps not directly concerned, psychologists will read this portion with interest, since implicit in these energy relations is supposedly the nature of the connexion between 'fact' and 'correlate'. It may well be that the useful, though problematical, concept of isomorphy will be unable to stand up in its present form against increasingly exact knowledge of retinal reactions. There are other complications, no doubt, but a better biophysics of colour-vision is evidently on the way.

Now for some of the applications. Many industrial matters demand the fixing of minute colour differences rather than absolute 'norms'. The Hardy spectrophotometer is excellent here, since much of the work may be concerned with reflexion, where the accuracy is most favourable. I have witnessed Hardy's machine at work upon reflectance measurements of specially prepared artists' pigments. Even allowing for somewhat elaborate calibration and checking, the speed at which the curves could be constructed was remarkable. As Dr Wright points out, one must not cavil at Hardy's inability to cope perfectly with fluorescence or specular reflexion, since these troubles are inseparable from the system. Nevertheless, the latter component can now be wholly included or wholly excluded, thus removing uncertainty. It is characteristic of the author's practical attitude that he adds a number of methods, more or less approximate, applicable to cases where complete spectrophotometry would not be justified. Much can be done by these means, so long as the absorption wave-length curve does not change direction too abruptly.

A chapter is devoted to colour atlases. These common adjuncts clearly suffer from the disadvantages of being incapable of supplying more than a fraction of all discernibly different colours and, moreover, they fade and get dirty. Nevertheless, they have their uses, as Dr Wright explains. An interesting forecast is that we might "in, say a hundred years' time", be able to do our colour matching and selection by means of the tristimulus values, X , Y , Z , alone. Meanwhile, we are driven by some psychological urge to ask for a pattern, transient as it may be. Musicians say they can appreciate perfectly a melody by reading the score, it is hard to see why artists should not do likewise some day, and obtain colour-harmony from the appropriate algebra.

Several other intriguing outlets for colorimetry follow: chemicals and their mixture, lighting, agriculture, pulp, paper and paint, signal glasses, photoelasticity and so on. In fact, their name is legion, and as if to practise what is preached, several excellent

coloured charts are included, some quite novel, and all of them helpful.

The price is the crux: for what is little more than a manual, thirty shillings does seem excessive. One would like to imagine a student reading this book time and time again, but if he does, he will probably have had to borrow a copy from somebody else.

F. IAN G. RAWLINS.

INTERACTIONS OF HEREDITY AND ENVIRONMENT

Livestock Improvement

In Relation to Heredity and Environment. By Dr J. E. Nichols. Pp vii+208+7 plates. (Edinburgh and London: Oliver and Boyd, 1944.) 10s 6d net.

THIS book, as the author says, attempts to outline the principles and to indicate how the genetic and environmental concepts are interwoven in the idea of livestock improvement. Much original work is included in the book, especially work on problems of sheep-breeding drawn from personal observations in many different countries.

In addition to an outline of the principles and details of genetics as applied to the breeding of farm animals, other factors closely linked with genetics and affecting livestock improvement are dealt with—such as environmental aspects, type and environment, and breed construction. These latter chapters indicate some of the problems which the applied animal breeder as distinct from the pure geneticist has to take into account. Here the idea of evolution as distinct from the modern analytical aspects of genetics creeps in, and the facts given may provide a means of bridging the gap between the ideas of Darwin and of Mendel, or between those of Lysenko and Vavilov. In particular, Nichols' conception of the stratification of the sheep industry in time and space provides the palaeontologist and zoologist with a concrete example of what has occurred, and is occurring, in the evolution of a species, or in the evolution of the fauna in a district. The agriculturalist's aim to control and change environmental conditions is from the zoologist's point of view a grand experiment in the evolution of animals. Throughout the book there is a number of references to work done in tropical countries, these should provide a basis for the development of the animal industry in British Colonies and other tropical countries.

The chapters on gene and character, frequency, inbreeding, outbreeding and hybrid vigour, and performance and progeny testing should prove most useful to the practical breeder of livestock, as they will enable him to see how the modern science of genetics can be usefully employed to effect a short cut to his objectives. The formulae given in several places may prove somewhat difficult to practical breeders, but they are reduced to the minimum that is necessary for proper comprehension by a student of the subject.

The book is packed with information concerning farm animals, well illustrated and has an extensive list of references to which the reader can go for further details. With government policy giving encouragement to the better breeding of farm animals, this book should meet a widespread demand from students, teachers and breeders for more information on the methods of livestock improvement.

JOHN HAMMOND.

CAUSALITY OR INDETERMINISM?

By PROF. H. T. H. PIAGGIO

University College, Nottingham

A SHORT article published in *Nature* of July 22, 1944¹, entitled "Collapse of Determinism", contained a brief statement of von Neumann's claim to have demonstrated that the results of the quantum theory cannot be obtained by averaging any exact causal laws. If one may judge from the number of communications referring to this point which have been submitted to the Editors, many regard this claim with suspicion and desire a more detailed discussion of the grounds on which it is based. Mr. W. W. Barkas² suggested that the existence of statistical regularity when large numbers of events are considered is incompatible with indeterminism, and that if the final result of the behaviour of a million photons were fixed, the behaviour of the first 999,000 must influence the other 1,000. Prof. (now Sir Edmund) Whittaker³ replied that it might be profitable to consider the behaviour of tossed coins. He asked, in particular, whether the statistical regularity for this case, calculated by the ordinary theory of probability, involves the assumption of 'crypto-determinism' (that is, real determinism hidden by lack of detailed information) or merely the assumption of symmetry. This reply produced further letters, too numerous for the Editors to publish in full, and I have been asked to give a connected account of the points raised. I shall start with the experimental evidence concerning coin-tossing, and contrast it with the theoretical discussion. After this I shall touch upon similar considerations for the kinetic theory of gases. Finally, and most important, I shall give some details of von Neumann's supposed disproof of causality, and give the arguments for and against it.

Buffon, the French naturalist, tossed a coin until he obtained 2,048 heads. The results were quoted by De Morgan⁴, who gave also an account of three similar experiments by his own pupils or correspondents. The arrangement by which the last toss ended with a head gave a small advantage to heads, but too small to make any significant difference. Much more extensive experiments, on somewhat different lines, were carried out by W. S. Jevons⁵, who took "a handful of ten coins, usually shillings", and tossed the ten together. He made two series of 1,024 such tossings of ten coins, so that in each series 10,240 coins were tossed. The results of these six experiments were as follows:

No of heads	2,048	2,048	2,048	2,048	5,222	5,131
No of tails	1,992	2,044	2,020	2,069	5,018	5,109
Total	4,040	4,092	4,068	4,117	10,240	10,240
Excess of heads over mean	28	2	14	-10.5	102	11
Proportion of heads	0.5069	0.5005	0.5034	0.4974	0.5100	0.5011
Excess over mean	0.0069	0.0005	0.0034	-0.0026	0.0100	0.0011

If we examine these results, we see that it is easy to misinterpret the meaning of 'statistical regularity'. It is certainly not true, as some correspondents seemed to think, that the numbers of heads and tails are bound to be equal. In fact, the divergence from the mean actually increased from a maximum of 28 in the first four experiments, each based on roughly 4,096 tosses, to a maximum of 102 in the last pair, each based on 10,240 tosses. This is quite in accordance with theory, which, assuming that the probability of a head in one toss is 0.5, deduces that for

a large number n of tosses, it is as likely as not that the divergence from the expected mean $n/2$ will exceed $0.3372\sqrt{n}$, but it is almost certain (99.73 per cent probability) that it will be less than $1.5\sqrt{n}$. For $n = 4,096$ the 'as-likely-as-not divergence' is, to the nearest integer, 22, and the 'scarcely-ever divergence' is 96. For $n = 10,240$, the corresponding numbers are 34 and 152. Thus the actual divergences, though larger and more one-sided than some might have expected, are quite compatible with the theory. But the phrase 'statistical regularity' really refers to the proportion of heads, which, according to theory, should be very nearly 0.5, with an 'as-likely-as-not divergence' of $0.3372\sqrt{n}$ and a 'scarcely-ever divergence' of $1.5\sqrt{n}$. Both these divergences diminish indefinitely as n increases. We may also estimate the theoretical divergence of the proportion by its root-mean-square or 'standard deviation'. This has the value $0.5/\sqrt{n}$, a result which we shall contrast later with Heisenberg's Principle of Uncertainty.

We now come to an important criticism of the theory of probability on which the above calculations are based. As pointed out by Lieut.-Colonel E. Gold⁶, there is an assumption of symmetry, not only in the two faces of the coin, but also in the actions of the hand that tosses the coin. When the hand was replaced by a machine, such as that devised by J. Horzelski⁷, the absence of this symmetry was manifest. By a certain adjustment of the pressure actuating a lever, he obtained 98 heads out of 100 tosses. He then slightly altered the pressure, keeping the head, as before, initially upwards on the machine, and obtained only one head in the next 100 tosses. In this case the tossing mechanism is not a hidden parameter, but is visible and definite, whereas in the usual tossing it is indefinite and, so far as we can manage it, symmetrically distributed. It is possible that the excess of heads in Jevons's experiments was due to some slight lack of symmetry in his tossing conditions. Whether this was so or not, it appears obvious that the description of reality given by the theory of probability in coin-tossing is not complete.

It is therefore erroneous to suppose that the properties of a perfectly normal distribution must necessarily correspond exactly with physical reality, however useful they may be in giving a good approximation to the facts. We cannot disprove the existence of the details of the projection merely by claiming that they upset the purity of the normal distribution. It is rather the very purity of that distribution which goes beyond the physical facts, and so is not a complete description of reality. Similar considerations apply to the kinetic theory of gases, but in this case the symmetry assumed in the theory⁸ is a much closer approximation to the actual facts. But it is only an approximation, and here, as elsewhere in classical physics, pure statistical aggregates do not exist.

This brings us to the question whether such aggregates exist in non-classical physics, in particular in quantum mechanics. We shall examine von Neumann's arguments, using for this purpose not only his well-known treatise "Mathematische Grundlagen der Quantenmechanik" (1932), but also the shorter account, in English, that he gave in Warsaw⁹ in 1937, and the discussion that ensued. The starting point is an analysis of the qualitative laws obeyed by the mathematical 'hypermaximal projective' operators which correspond to the physical quantities occurring in quantum mechanics. Everything is said to be based on six laws, of which two seem more

important than the rest. One is the principle of superposition, extended to quantities not necessarily simultaneously measurable. The other may be called the principle of exact functional correspondence, for example, if an operator represents a physical quantity, then the square of the operator represents the square of the quantity.

In my opinion, however, the emphasis on these simple laws conceals the fact that other conditions of greater importance are imposed by the definition of 'hypermaximal projective' operators. This definition implies some characteristic results of quantum mechanics, and the simple laws are merely the final requirements. Von Neumann shows that aggregates are of two kinds, 'pure' and 'mixed'. The essential property of a pure aggregate is that it cannot be regarded as a mixture of two other non-identical aggregates. The qualitative laws of quantum mechanics show that the aggregates concerned must be pure, whereas all aggregates based upon causal laws, such as tossed coins or gas particles, must be mixed. Hence, he concludes, causality is incompatible with quantum mechanics, and the process of averaging causal laws, as applied in the kinetic theory of gases, cannot possibly be extended to quantum mechanics. There is no need, he says, to go more deeply into the details of a supposed system which is governed by further conditions ('hidden parameters') in addition to the wave functions. These hidden parameters would upset the qualitative laws of quantum mechanics. He admits that quantum mechanics in its present form is certainly defective, and, in spite of its great success in explaining physical phenomena, may possibly, in the long run, turn out to be false. But this is true of every theory, we can never say that it is proved by experiment, but only that it is the best summing up of experiment at present known.

Von Neumann therefore concludes that there is at present no reason and no excuse for supposing the existence of causality in quantum mechanics. This conclusion is described by Whittaker⁹ as not only novel and unexpected, but also almost incredible, yet he endorses it with the exultant declaration "the bonds of necessity have been broken, for certain classes of phenomena, crypto-determinism is definitely disproved".

Other comments have been more sceptical. At the Warsaw conference, the president, C. Bialobrzelski, after hearing von Neumann, admitted the validity of the argument that it was impossible to fit causality into the framework of quantum mechanics, but expressed a doubt as to the logical coherence of that framework. In his opinion it is deficient because it does not take account of irreversible changes, and also because, in certain conditions of measurement, the indeterminism of the final state disappears, and the assumptions of discontinuity and indeterminism do not correspond to reality. He thought it necessary to introduce a new postulate concerning measurement. At a later meeting of the same conference a letter from Heisenberg said that the quantum theory, in its present form, could not yet give a logically coherent account of nuclear physics or of cosmic rays.

Many critics are suspicious of purely abstract arguments which make no reference to experiment. Of course, such experiments as those of Davison and Germer on electron diffraction and of Condon and Gurney on radioactivity, though excellent as illustrations of the Uncertainty Principle, yet have no value in deciding whether this uncertainty is due only to

lack of detailed knowledge, or to true indeterminism. On a somewhat different plane is the argument of Whittaker⁹, who, though a supporter of von Neumann, illustrates his argument by a reference to the passage of plane-polarized light passing through a Nicol prism, and shows that the phenomena cannot be explained by causal laws governing any hidden parameters attributed to the photons. However, H. Pelzer¹⁰ gives two models in which hidden parameters, attributed at least partly to the Nicol prism, can exist and obey causal laws. From this he infers that the arguments of Whittaker and von Neumann are incomplete, even though he agrees with their conclusion that quantum phenomena are truly indeterminate.

My own criticism of von Neumann is founded upon a paper by A. Einstein, B. Podolsky and N. Rosen¹¹. By considering the problem of making predictions concerning a system on the basis of measurements made on another system which had previously interacted with it, they conclude that *the description of reality as given by a wave function is not complete*. As a wave function is a mathematical way of representing a probability distribution, this conclusion is almost exactly the same as that which I enunciated concerning coin-tossing. I therefore, with great diffidence, offer the opinion that the existence of causality has *not* been disproved. It is true that Einstein's opinion has been rejected by N. Bohr¹², but there are other grounds for supporting it. In fact, the postulate of quantum mechanics that electrons cannot be distinguished from one another appears, at least to me, not to be a statement that Nature is incomprehensible, but merely that quantum mechanics is incomplete. However, I do not wish to insist that there is no difference between coin-tossing and quantum mechanics. One striking difference is that in coin-tossing the standard deviation of the proportion of heads depends only upon the number of tosses, and can be diminished indefinitely, but in quantum mechanics the Principle of Uncertainty gives for the product of the standard deviations of the momentum and displacement a minimum value, namely, $h/4\pi$. The occurrence of Planck's constant in this result seems to show that there is something essentially new. I should find it easier to accept von Neumann's conclusions if his arguments, instead of being purely qualitative, contained this constant. Perhaps it is really concealed somewhere in the background, like a hidden parameter.¹

To conclude, I will quote the opinion expressed by Bertrand Russell¹³ in 1936, that at present there is no decisive reason in favour of complete determinism (causality) in physics, but that there is no reason against it, and that it is theoretically impossible that there should be any such reason. But Russell does not mention von Neumann's arguments. My own conclusion is that the balance of the present evidence is rather against complete causality, but that the question is still unsettled.

¹ *Nature* 154, 122 (1944).

² *Nature*, 154, 876 (1944).

³ "Budget of Paradoxes", 170 (1872).

⁴ "Principles of Science", 238 (1874), or 2nd ed., 208 (1877).

⁵ *Nature*, 155, 111 (1945).

⁶ *Nature*, 155, 111 (1945).

⁷ Preston, "Theory of Heat", 4th ed., 782 (1929).

⁸ "New Theories in Physics", 30-45.

⁹ *Proc. Phys. Soc.*, 55, 459 (1943).

¹⁰ *Proc. Phys. Soc.*, 55, 195 (1944).

¹¹ *Phys. Rev.* 47, 777 (1935).

¹² *Phys. Rev.* 48, 696 (1935).

¹³ *Proc. Univ. of Durham Phil. Soc.*, 9, 228 (1936).

CONSTRUCTION OF THE SHOOT APEX IN CEREALS AND OTHER GRASSES

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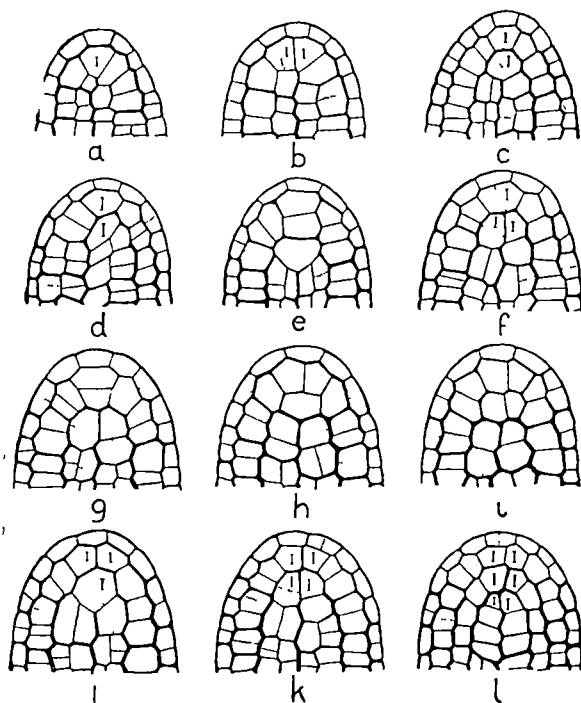
THE reawakening of interest in the developmental anatomy of the shoot apex has been paralleled by considerable advances in technique and by a growing realization that the answers to many genetical problems are locked up in a better understanding of the processes at work during the ontogeny of the organism. For a number of reasons, our knowledge of apical architecture is, so far, most advanced in the Gramineæ: here we are now in the happy position of realizing that much of the early controversy arose, not from incorrect recording of facts, but from the participants failing to realize that they were dealing with separate chapters of the same story. Although all members of the family probably conform with the scheme set out in the present résumé, for convenience reference is mainly made to species already discussed in the literature.

In the Gramineæ, the apex is always a comparatively elongated structure, with the cells at the extreme tip rather larger than those in the zone of leaf initiation and with less easily stained nuclei and a suggestion of being more vacuolated. The outer cells form a single thumb-shaped layer—the dermatogen—and normally only divide antichnally. They may sometimes originate from a single ill-defined apical 'initial', but more usually come from an even more indefinite group of 'initials'.

At the extreme tip it is often difficult to determine the arrangement of the internal cells, but a short distance back they are always found to be arranged in at least a hypodermis and sub-hypodermis, each one cell thick, which form concentric shells clothing a core of more vacuolated, less rapidly dividing tissue of a sort of 'apical pith'.

The dermatogen, hypodermis and sub-hypodermis maintain their individuality because the cells forming them divide only by antichnally walls until a new leaf is initiated. Then successive perichnally divisions occur in the cells of the dermatogen and hypodermis, while the cells of the sub-hypodermis under the insertion of the new primordium only divide perichnally once. On the other hand, at the origin of the axillary bud the sub-hypodermal cells repeatedly divide perichnally, but those of the dermatogen, and usually the hypodermis also, only divide antichnally.

The inner cells may originate in a variety of ways. In young seedlings and perhaps throughout most of the vegetative life of some slender grasses, they can all be traced back to a single 'segmenting' apical cell as in Fig. *a*. Sometimes (Fig. *b*) more than one apical cell is present, when the segments cut off produce the inner tissues as they are left behind. In both these types the first products of division of the one or more initials immediately divide once perichnally to give a cylinder (the hypodermis) one cell thick surrounding a core at first two cells in diameter. In older or more massive shoots there may be two superimposed initials (Fig. *c*), one giving rise to the hypodermis and the other to the rest of the internal tissue. Occasionally the situation in Fig. *d* occurs, where the inner initial cuts off cells to one side only, and these immediately divide once (the



outer cell giving the hypodermis of that side), while the upper initial cuts off cells destined on one side to be the hypodermis but on the other side to divide perichnally once, the outer cell becoming a hypodermal cell. These four types are those reputed to be usual for *Avena*¹, *Secale*² and *Triticum*² during their vegetative period, although even here a perichnally division in the 'initial' cell of the hypodermis every now and then leads to the displacement backwards of the old inner initial and its subsequent loss by differentiation (Fig. *e*). In other grasses, at least, apices can be found where there is a single 'initial' for the hypodermis and two or more for the central tissues (Fig. *f*). Here again an occasional perichnally division in the hypodermal initial leads to the displacement of the inner initial as in Figs. *g*, *h* and *i*. Fig. *h* also suggests a possible method of origin of apices of the more complex type seen in Fig. *j*, where there are two or more 'initials' for the hypodermis overlying a single one below. Similarly, Fig. *i* suggests a mode of origin of the more massive type of apex shown in Fig. *k* with two or more hypodermal initials and two or more initials below.

Progressively during ontogeny the apex usually tends to possess more initials, and the hypodermis tends to have an initial or initial group of its own superimposed upon the initial or initial groups of the more central cells. Although in the more massive types the hypodermis undoubtedly behaves as a distinct self-perpetuating layer for considerable periods, occasional perichnally divisions at the extreme tip may probably occur at any time and so lead to the displacement of the initials below. Not all species have apices of the same complexity at comparable times in their developmental history leading to inflorescence production. Thus, for example, although *Avena*¹, *Secale*² and *Triticum*² may have a separate initial or initial group for the hypodermis towards the end of the vegetative period, this only becomes a permanent feature from the time of inflorescence initiation, while in *Agropyron repens* Beauv. (un-

published) even the rhizome apex seems to have a discrete hypodermis and the aerial shoot often approximates to the state of affairs in Fig *k*. The condition represented in Fig *l* can be found at the tip of the developing inflorescence of *Agropyron*, but this may not be a permanent feature. The possibility of three tiers of internal initials is also suggested for some of the main shoots in bamboos (*Phyllostachys*³ and *Snocalamus*⁴), but there is need for further investigation here.

Axillary buds have a construction either similar to or simpler than the main apex. Thus in *Avena*, *Secale* and *Triticum*, where periclinal divisions are frequent in the hypodermis at the tip of the main shoot, a similar situation is found in the apices of the axillary buds. On the other hand, in *Agropyron*, *Snocalamus*⁴ and *Zea*, where the hypodermis remains as a discrete layer at the tip of the main shoot, periclinal divisions are absent from the apices of the axillary buds.

For want of a better term, the cells to which the internal layers can be traced back in the apex have been termed 'initials', but it is only rarely that they approach anything at all like the classical idea of an apical initial. They are not large, well-defined, well-vacuolated cells cutting off segments with a volume considerably smaller than their own. Instead they are usually rich in cytoplasm and divide into almost (? quite) equal parts, and the one which happens to be nearer the tip is destined to continue as the initial merely because of its position. All the cells of quite a large group are totipotent, and their positioning in the apex is probably governed by laws comparable with those which determine the packing patterns of bubbles in the end of a test tube rather than by any qualities inherent in the cells themselves. Moreover, the position taken up by a cell governs its subsequent development.

The view that the exact mode of origin of the inner tissues of the apex is not significant is further confirmed by the constant development behind the apex of the hypodermis and sub-hypodermis, often quite irrespective of details of segmentation at the actual tip, demonstrated especially by apices of the type shown in Fig *d*. From recent studies it is becoming increasingly evident that the zonation of all apices is to be thought of in terms of levels of relative differences in aeration, nutrition, etc. It is not a morphological but a metabolic zonation rather akin to a gardener's 'top-soil' and 'sub-soil'. The nearer a cell is to the surface, the more it tends to divide exclusively by antichlinal walls, an effect which bears absolutely no relationship to the number or positioning of the 'initial' cells, and which leads to the production a little way back from the extreme tip of clearly distinguishable layers, the numbers of which will tend to be greater the more massive the apex. In grass apices of the long type this zonation will be very noticeable, but it will be masked in short apices by the divisions connected with the onset of leaf and bud initiation. The metabolic view also makes the observed occasional periclinal divisions unconnected with leaf initiation in the dermatogen itself to be expected, especially in very young axillary buds or the plumules of young seedlings.

Since the exact origin and fate of the various layers are so flexible in the grass apex, Hanstein's terminology cannot be used in its strict sense, nor is the *tunica-carpus* terminology in Buder's⁵ (but not in Schmidt's⁶ and Foster's⁷) sense very useful. However, using these and Koch's⁸ similar terminology

(originally suggested for Gymnosperms) purely as descriptive of the tissue zonation of the apex without any implications as to derivation or destiny, the equivalents are as follows.

Tissue	Hanstein	Koch	<i>Tunica-carpus</i>
Outer layer	Dermatogen	Mantle (Hüllgewebe)	Tunica
Hypodermis	Outer periblem	Mantle	Tunica
Sub-hypodermis	Inner periblem	Mantle	Corpus (? or transition layer)
Inner core cells	Plerome	Central tissue	Corpus

The construction of the apex has considerable interest for the plant-breeder who wishes to obtain viable gametes by doubling the chromosome complement with colchicine, etc. This is obviously best achieved by affecting the tissues eventually traceable to the hypodermis of the flower-bud primordia. He need not consider whether the main axis has a single initial or a group of initials for both the hypodermis and the inner tissues, and whether or not periclinal divisions occur in the apical cells of the hypodermis of axillary buds. He must merely realize that the earlier he treats his seedling the better because (1) in young seedlings the whole of the hypodermis is being derived from fewer initials, so that should he have the good fortune to produce a doubling in an initial, it will produce a wide sector of cells with the new constitution, and it may also be the parent of some of the other initials when the group increases in number, (2) even if he succeeds in only doubling the complement of a hypodermal cell on the flank of the apex, if effected early this will be represented in all the tiller buds from that sector, whereas successively later local doubling in the hypodermis will only affect blocks of primary, secondary and then tertiary, etc., inflorescence buds (in the case of a paniculate inflorescence), or spikelet buds and later only floret initials.

¹ Klem, F., *Beit Biol Pflanzen*, 24, 281 (1937)

² Rosler, P., *Beit Biol Pflanzen*, 5, 28 (1928)

³ Porterfield, W. M., *Peking Soc Nat Hist Bull*, 4 (3), 7 (1930)

⁴ Hsu, J., *Amer J Bot*, 31, 404 (1944)

⁵ Buder, J., *Ber Bot Ges*, 43, 20 (1928)

⁶ Schmidt, A., *Bot Arch*, 8, 345 (1924)

⁷ Foster, A. S., *Bot Rev*, 5, 454 (1939)

⁸ Koch, L., *Jahrb wiss Bot*, 22, 491 (1891)

EXPERIMENTAL MORPHOLOGY OF PTERIDOPHYTES

PHYSIOLOGICAL and experimental observations have hitherto played virtually no part in helping to elucidate problems connected with the organization of the plant body in Pteridophytes. The approach towards these problems has been almost exclusively morphological in inception and outlook. Some experimental investigations recently recorded by Prof C. W. Wardlaw (*Ann Bot*, New Series, 7, Nos 26 and 28, 8, Nos 30/31 and 32, April and Oct 1943 and April-July and Oct 1944) dealing with bud development and stelar morphology in ferns have yielded results of great interest and significance which indicate the value and potentialities of this previously neglected approach to morphological problems.

It has long been held that one of the morphological characteristics distinguishing ferns from seed

plants is the inconstancy in the positional relationship of buds to shoot and leaf in the former group. Though sometimes they occupy definite axillary positions, they commonly arise in extra-axillary positions which apparently show no fixed relationship to the foliar organs. Prof Wardlaw's observations, however, suggest that, though the final position of the bud is so variable, its point of initiation does in fact show a definite relation to the foliar organs, and the ultimate position it comes to occupy is explicable in terms of relative growth activities.

Investigations on *Matteuccia struthiopteris* and *Onoclea sensibilis* have shown that, on the normally unbranched rhizomes of these dictyostelic species, buds may be induced by removal of the terminal meristem. These buds are initiated in superficial areas of meristematic cells which, in the normal rhizome, remain quiescent. The origin of the patches of meristematic cells can be traced to the apical meristem, from which they become detached and persist on the surface of the shoot in definite positions corresponding to the point of union of the meristemes at the distal end of the leaf gap, that is, in the axis of a leaf but some distance above its insertion.

In *Dryopteris Filix-mas*, defoliation experiments involving the removal of fronds and destruction by puncturing with a needle of the smallest visible leaf primordia proved effective in bud formation. The buds were situated either on the leaf-base near its point of confluence with the shoot or some distance along the petiole. Investigation showed that the buds always arise on the shoot in an approximately axillary position, despite the abaxial position at some distance above the petiole base which they eventually may come to occupy. Their origin was traced to the activity of epidermal cells lying in close proximity to points of meristeme conjunction in the vascular meshwork of the shoot and therefore comparable in position with those of the other species investigated.

The position which the bud ultimately comes to occupy on the petiole is due to the very great transverse growth expansion of the basal region of a developing leaf primordium. This causes displacement of the much more slowly growing bud from its original axillary position, and leads to its being carried up on the enlarging base of a developing frond. The enlarging frond base on which the bud is thus caught up may lie in a longitudinal or a lateral position with respect to the bud, so that the bud may become separated in space from the leaf to which it originally stood in an axillary relationship.

Further observations along these lines may well reveal that the point of origin of buds is fundamentally the same in all ferns, and that the varied positions which they eventually occupy may be wholly explicable in terms of specific growth distribution in shoot and leaf.

In the field of stelar morphology, chief consideration has always been devoted to fully differentiated tissue systems, and though a fairly complete picture has been obtained of the progressive increase in complexity of the stele during ontogeny, little attention has been paid to the development of the shoot as a whole from the apex backwards. Hence developmental studies in the stelar morphology of ferns, comparable in detail with the ontogenetic studies of their reproductive structures or with the dynamic aspect of tissue differentiation behind the growing point in the Angiosperms, are not available.

Prof Wardlaw recognizes two phases in the development of vascular tissues, namely, the "initial differentiation", whereby vascular tissue can be distinguished from cortical tissue, and the "subsequent differentiation" characterized by the specialized development of the constituent vascular elements. It is in the region situated immediately below the apical meristem that the "initial differentiation" takes place, and it is suggested as a working hypothesis that this initial differentiation of vascular tissue is inseparably connected with the immediate proximity of an apical meristem in a state of active growth, its position and behaviour being causally related to one or more unspecified substances diffusing from the meristematic cells.

Evidence adduced for the Pteridophytes in general is fully in accord with the fact that wherever an actively growing apex is present, vascular tissue may be observed in the process of differentiation immediately behind it. Moreover, that the maintenance of the actively meristematic condition is all-important is indicated by the disappearance of the zone of initial differentiation behind dormant apices. It is shown that the discontinuous vascular strands which have been described by Holloway in large prothall of *Psilotum triquetrum* are associated with discontinuous apical activity, while instances cited of vascular tissue differentiation in experimentally induced buds on fern rhizomes, in the protocorms of Lycopods and their attached leaves, and in certain regenerative growth processes which have been described in *Lycopodium Selago*, all clearly point to the fact that where the apical growth is not actively maintained, stelar tissue is not differentiated.

The application of experimental methods to the problem of the relation of leaf development to stelar morphology in ferns has yielded results of outstanding interest. These results throw new light on the factors determining the form of the axial stele and supply an answer to the much-debated question of the cauline versus foliar nature of the stelar stele.

It was observed that in *Dryopteris Filix-mas* immediately below the apical meristem, there is an uninterrupted ring of vascular tissue in the initial stage of differentiation, while in the earliest stage of development of the fronds the vascular supply to the young primordia shows no leaf gaps. These develop a little later, their formation being associated with mechanical stresses resulting from the enlargement of the vascular systems of the leaf bases. Experimental verification of this relationship was sought by defoliating rhizomes and destroying the young leaf primordia by needle puncturing with a micro-manipulator. The apical meristematic cone alone was left intact. The rhizomes were planted in moist peat and new leaf primordia were regularly destroyed as they developed. The suppression of leaf growth was found to lead to the failure of leaf gaps to form, and therefore to the substitution of a solenostele in place of the dictyostele characteristic of this species. When new leaf primordia were allowed to develop again on treated rhizomes, the specimens showed solenostely in the treated region of the shoot, with a return to normal dictyostely in the terminal region. Similar experimentally induced solenosteles were obtained in *Onoclea sensibilis*. The development of a substantial shoot stele in both species in the absence of any associated leaf growth affords proof of the truly cauline nature of the stele.

W. A. SLEDGE

ORGANIZATION OF RESEARCH IN THE U.S.S.R. INSTITUTE OF PHYSICAL PROBLEMS

ON May 18, 1943, Prof P Kapitza presented a very long report at the meeting of the presidium of the U S S R Academy of Sciences in which he dealt with the organization of scientific work at the Academy of Sciences. An official translation into English of parts of the report has recently been made available in Great Britain in Bulletin, 9-10, 1943, of *WORKS*, the organ of the U S S R Society for Cultural Relations with Foreign Countries and has been used in the preparation of the following account*.

On the basis of his experience at Cambridge, Prof Kapitza felt that the organizational forms of scientific work accepted in the West could not be applied unchanged in the U S S R. "This is principally caused by the fact that in our socialist country science occupies a special place. Of course it is well known and commonly accepted in the other countries too, that science plays a great role in the development of the culture and technology of the country. But in our country science is recognized as one of the essential mainstays of the development of culture and is accorded a leading position in the development of our technology and national economy. For this reason the organization of science in our country must have a more purposeful character than that to be found in other countries, where it is rather accidental and spontaneous. The connection between science and life must be close and more complete."

As Prof Kapitza's Institute is so young—it is only even or eight years old—and moreover is devoted to work on strong magnetic fields and low temperatures, which was but little developed in the U S S R. At the time, the first years were spent in forming and training the scientific personnel and staff. "The question I put before myself from the very outset was what sort of problems must an institute of the Academy of Sciences work up? I had in mind an institute of physics or an institute devoted to research in the field of natural science. I emphasize further that I am speaking in particular of the organization of an institute of the Academy of Sciences. What is the Academy of Sciences? It is the Chief Headquarters of Soviet Science. In my opinion it is called upon to direct all our science ideologically, from top to bottom, along a sound channel. Each of its separate institutes must pursue the same policy, that is, aspire to wield a directing influence on science in the field in which it is working, and strive to bring it into the front ranks. For this reason, the first task which an institute of the Academy of Sciences must set itself is to study a 'great science.' In the official translation, 'great' is used throughout, but from the definition given it would appear that the correct translation is 'pure' as distinct from applied science. 'Great' science is 'the science that studies the essential phenomena necessary for the most profound knowledge of nature', but it is explained that "the task of a science is to give the necessary knowledge for transforming nature so that it can serve man in his cultural development." For this reason the choice of the fields of research of an institution is extra-

ordinarily important, and Prof Kapitza would choose the fields of low temperatures, the atomic nucleus and the solid state as the most important at the present time.

"Only a person with a profound creative talent and one who treats his work creatively can achieve considerable success in 'great science'. For this reason the leading group of the institute must undoubtedly be formed from a few carefully picked workers who must devote themselves wholeheartedly to scientific work with not more than twenty per cent of their time given up to social or other non-scientific activities." From the emphasis laid upon conditions that the worker must be able to stay in the laboratory and himself work there, it is clear that Prof Kapitza would not approve of what might be called 'office' research in which meetings and memoranda continually interrupt actual research work. "Only when one works in the laboratory oneself, with one's own hands, conducting experiments even the most routine parts of them,—only under these conditions can real results be achieved in science. Good work cannot be done with other people's hands. I am certain, that the very moment even the greatest scientist stops working in the laboratory himself, he not only ceases to develop but, in general, ceases to be a scientist. These principles are very important, but they belong only to peace-time, war-time forces us to act differently."

The greatest emphasis is laid upon these principles, particularly with beginners. "For this purpose I try to put their work into rather rigid organizational frames. For instance, a scientific worker must not be occupied with several subjects at one time, especially if he is at the beginning of his scientific career. When the scientific worker has grown somewhat and become more experienced, he may be able to work simultaneously on two or three subjects as a rare exception, but he must always begin with one."

Attention is then directed to the dangers of overwork. "The next point in the organization to ensure successful work, is that the scientist must work in the laboratory a limited number of hours. Long spells of work are harmful, it is exhausting and lowers a person's creative powers." The regime observed by the workers in the Institute for Physical Problems at Moscow is that usually all laboratory work stops at 6 p.m., after which the worker leaves for home "to ponder on his work, read, study and rest." Exceptionally, by permission of the vice-director, work may continue until 8 p.m. Night work is sanctioned only by the director when it is justified by technical necessities of the experiment.

The next problems discussed are how such an Institute can influence the development of the science of the country and can avoid becoming a closed and isolated unit, which latter would be contrary to one of the principles laid down earlier. Several means are discussed. First of all, full advantage must be taken of the privileges of an institute of the Academy of Sciences, whereby the Institute has access to "rich and modern technical equipment" and to a wide field in selecting experienced staff. The special plant for making liquid helium in quantity gives the Institute for Physical Problems exceptional possibilities for doing experiments at very low temperatures. Next, these facilities are made available to workers in other institutes. Such visits are usually arranged as follows: "The comrade who wishes to work at our institute is invited to our scientific meeting where he reports on

* A complete translation of the speech together with that of a long discussion has been made by the Science Section of the Society for Cultural Relations with the U S S R, 98 Gower Street, London, W C 1.

the experiment he proposes to conduct. This is discussed and, if the proposal is of scientifically grounded interest and the author is sufficiently qualified, he is given the opportunity to do his work." Not more than two or three outside workers can be accommodated at the same time without disorganizing the main work of the Institute. So far there have been more suitable applications than could be accommodated.

These guests form a vital link with other institutes, for not only is a knowledge of the work of the Institute for Physical Problems spread by them but also the guests keep the Institute informed of what is being done elsewhere. Prof Kapitza is no believer in isolation, as the following passage shows: "In the future similar vital contacts must be established with scientists in other countries. Scientific workers from abroad visited us during the first years of the existence of our Institute. But in recent years the political situation has grown so complicated, that though there were those who wanted to come here, our connections with foreign countries had been severed, so we can only speak of this aspect of our relations with foreign scientists in view of plans for the future. But these relations must, of course, be deemed a normal and sound condition of the work of any academic institute, because science throughout the world comprises one indivisible whole."

Another function of the Institute is to train scientific workers. Prof Kapitza was not satisfied with the external method of selecting postgraduate students. "Only the institute itself can train its future personnel, and it must do so with great diligence, by gradually nurturing them from youth." The method of selection used for two or three years before the War gave unique opportunities to students at the University of Moscow. "Taking advantage of the fact that we possess greater amounts of liquid helium for experiments at low temperatures than the refrigerating laboratories of the whole world put together, we were in a position to set up a practicum at the institute, which is attended by every student of the Moscow University School of Physics." At first, only the best students were admitted, but later every student was allowed to do two or three experiments, using liquid helium for the study of such phenomena as superconductivity and magnetic properties near 0°A . The best of the students, if they wished, were allowed to do more than the three experiments, and from the beginning of their third or fourth university year were in close contact with the Institute. Later they were invited to help with the research work as junior laboratory assistants. Prof Kapitza thinks that if the scheme had not been interrupted by war, probably one out of ten or fifteen of these students, on completing their graduate work, would have proved sufficiently talented to remain on the main scientific staff of the Institute.

"This method of observing young students from the time they are at the university, the thorough and constant verification of their abilities is, in my opinion, the only correct way of selecting young scientific workers, so far. As you grow older, it is only young people, only your pupils, who can save you from premature mental staleness. Of course, every pupil must know more about the field in which he is working than his teacher. And who teaches the teacher, but his pupils? Thanks to his experience the teacher supervises the general fund of the work, but he is taught by his pupils, who deepen his knowledge and extend his scope." The difficulty of making

correct statements about the human being doing creative work is illustrated by Kapitza's statement that "without pupils the scientist very soon dies as a creative unit and ceases to advance." Faraday had no pupils. Rutherford told Kapitza that "it is only because of my pupils that I, too, feel so young." Prof Kapitza ends the first section of his address with the words "as I myself am approaching old age, I feel that intercourse with youth must be the *modus vivendi*, safeguarding one from withering away and insuring the maintenance of courage and interest in all that is new and advanced in science. Conservatism in science is worse than premature death to a scientist, it acts as a brake on the development of science."

W. H. GEORGE

OBITUARIES

Dr G. D. Bengough, F.R.S.

DR GUY DUNSTAN BENGOUGH, whose name is particularly associated with research on the corrosion of metals, died in the East Sussex Hospital, St Leonards, on January 20. He was born in 1876, the son of Major E. B. Bengough, and was educated at Malvern and at Selwyn College, Cambridge. He then studied metallurgy at the Royal School of Mines and worked for a short time at the Royal Mint, gaining experience in research under Sir William Roberts-Austen. He went to Burma for practical experience in the extraction of gold and tin ores, and then held teaching posts in the Universities of Birmingham and Liverpool.

While at Liverpool, Bengough published papers on the rupture of metals at high temperatures, in which he showed that the normal fracture through the crystals of a metal gave place to one passing between the crystal grains when a certain critical temperature was exceeded. This he attributed to the presence between the grains of a non-crystalline layer, having some of the properties of a glass, being rigid at low and viscous at high temperatures. The same idea was suggested independently by Dr Rosenham, and this conception of an 'amorphous intercrystalline cement', although questioned by some, became popular, and long served as a basis for research.

It was while at Liverpool that Bengough began work on the corrosion of metals, especially brass marine condenser tubes, for the Institute of Metals. A series of reports was issued, in which the conditions determining general corrosion and pitting were examined, and new experimental methods were devised. The work was interrupted by the War of 1914-18. Bengough obtained a commission in the Royal Artillery, and in 1916 was captain and adjutant. He was, however, seconded for work for the Admiralty and later for the Royal Flying Corps, and continued work on corrosion in the Royal School of Mines. He later became a principal scientific officer in the Chemical Research Laboratory at Teddington, and from then onwards devoted himself to the investigation of corrosion, giving special attention to the design of apparatus.

In 1926 Bengough devised the method of anodic protection of aluminium and its alloys which proved of very great industrial value. Not only did the film produced by his method give a high degree of resistance to corrosion, but also it could be given a definite degree of porosity, so that the surface could be made to take dyes or pigments, opening up a wide field of

decorative work. He was also responsible for a method of protecting magnesium and its alloys by depositing selenium, which, however, had certain practical disadvantages.

Much of Bengough's later work was done for the Joint Corrosion Committee of the Iron and Steel Industrial Research Council and the Iron and Steel Institute, and after retiring from Teddington in 1936, he continued to act as consultant to that body and to the Department of Scientific and Industrial Research, being chairman of the Marine Corrosion Sub-Committee.

Bengough's work was marked by a high standard of accuracy. He devised methods by which extraneous factors were so far as possible excluded, so that the results were reproducible. By using carefully designed apparatus, he determined the course of the corrosion process by measuring the absorption of oxygen and when necessary the evolution of hydrogen, so that characteristic corrosion-time curves could be drawn. Such carefully selected conditions cannot, of course, reproduce those of attack on a ship's plate or a condenser tube, and the relations between laboratory results and practical experience have been the subject of much controversy. Bengough laid most stress on the properties of the products of corrosion in determining its subsequent course, whereas Dr U R Evans and his collaborators attached chief importance to the principle of differential aeration. The two investigators were approaching the problem from different angles, and their views were less irreconcilable than they had seemed at first, so that in 1938 a joint statement was issued which showed how great was the measure of agreement. A series of six papers by Bengough and his colleagues in the *Proceedings of the Royal Society*, of which he was elected a fellow in 1938, contains an account of a long series of quantitative experiments on corrosion. Other laboratory work is described in the reports of the Corrosion Committee published by the Iron and Steel Institute, and here his chief service was that of laying down the conditions which must be observed in making standard tests of corrodibility.

Tall and military in appearance and seemingly robust, Bengough had long periods of serious illness before that which led to his death. He was a good chairman and always showed good temper and courtesy in dealing with a notoriously controversial subject.

Dr. Bengough married Constance Helen, daughter of Lieut-Colonel Jelf-Sharp, who survives him.

C H DESCH

Prof. V. I. Vernadsky

PROF VLADIMIR IVANOVICH VERNADSKY, one of the leading mineralogists and geochemists in the U.S.S.R., died on January 6. He was born at St Petersburg on March 12 (February 28, Old Style), 1863. After graduating at the University of St Petersburg in 1886, he spent some time in Paris working in the laboratories of Le Chatelier and Curie, and in 1896 was appointed professor of mineralogy at the University of Moscow. In 1906 he was elected a member of the Russian Academy of Sciences.

Prof Vernadsky's early work was devoted to a chemical study of aluminosilicates, a subject which he later expanded and applied in a wider field of the structure of silicates and especially of kaolinite, feldspars and chlorites. At the same time he was

working on descriptive mineralogy and he described and named a number of new minerals. In his lectures at the University he began to break new ground by stressing the genetic aspect in mineralogy. This genetic approach to mineralogy was fully developed in his books "Essay on Descriptive Mineralogy" (1908, 1910) and "History of Minerals of the Earth's Crust" (1925, 1933). Eventually genetic mineralogy overstepped its proper boundaries and became merged in the far wider field of geochemistry. Thus Vernadsky may be considered the founder of the new Russian school of geochemistry, which has made such gigantic strides during the last three decades.

The greater part of Vernadsky's work on geochemistry appeared in the form of numerous papers, but a good presentation of it may be found in his book "La géochimie", published in French in 1924. It is a most stimulating book, full of daring ideas and wide generalizations. But even more daring is his book "La biosphère", published in 1929, in which he made an attempt to incorporate biological processes into his general scheme of geochemistry.

Endowed with a versatile genius and full of tremendous energy and enthusiasm, Vernadsky spread his activities far and wide. He organized regular research in mineralogy and geochemistry, helped to establish the Mineralogical Museum in Moscow, promoted the establishment of numerous scientific institutions—such as the Biogeochemical Laboratory, the Radium Institute, a permanent committee for the study of meteorites, and others. He was also the founder and the first president of the Ukrainian Academy of Sciences. Vernadsky was well known outside the U.S.S.R. Since 1920 he spent some years in Paris and Prague working and lecturing. He was a member of the Paris Academy of Sciences and the Czechoslovak Academy. He visited Great Britain in 1923, when he took part in the meeting of the British Association in Liverpool.

Vernadsky's direct contributions to science are considerable, but they are dwarfed by the greater importance of his influence on the development of new ideas in geochemistry and mineralogy. As a teacher he was most stimulating. He could easily divert the wealth of his erudition into fresh channels and mark out new lines of research. He was greatly admired and loved by his pupils and colleagues, even by those who violently opposed his views.

A bibliography of Vernadsky's works up to 1936 was given in the 'Vernadsky Jubilee Volume' published by the Academy of Sciences of the U.S.S.R., two articles in *Bull. Acad. Sci. URSS, Géol. Sér.*, No. 1 (1944), one by D P Grigoryev (p. 25) and the other by V G Kryzhanovsky (p. 35) give an account of his work, and a short account of the development of geochemistry in the U.S.S.R. has appeared in *Nature* (154, 814, 1944). S I TOMKEIEFF

WE regret to announce the following deaths:

LORD DAWSON OF PENN, PC, GCVO, KCB, president during 1931–38 of the Royal College of Physicians, on March 7, aged seventy-nine.

Prof F W Eurich, emeritus professor of forensic medicine in the University of Leeds, known for his work on anthrax, on February 16, aged seventy-seven.

Sir Duncan Wilson, CVO, CBE, until 1940 chief inspector of factories (Home Office), and secretary during 1918–30 of the Industrial Health Research Board, on March 1, aged sixty-nine.

NEWS and VIEWS

Royal Scottish Museum, Edinburgh

Mr Thomas Rowatt, OBE

ON reaching the age limit, Mr Thomas Rowatt has recently retired from the directorship of the Royal Scottish Museum, which he has held since 1934. He entered the Civil Service as assistant in the Technological Department of the Royal Scottish Museum in 1902, became assistant-keeper in 1909 and keeper of the Department in 1921. The period of his directorship marked steady progress in the development of the activities of the Museum, and though the building was closed to the public on the outbreak of the War, and its valuable collections were dispersed to places of safety, Mr Rowatt has in recent years arranged for special exhibits which have proved attractive to the people of Edinburgh and to the city's many visitors from overseas. Perhaps the most popular of these has been the present Fisheries Exhibition, arranged in co-operation with the Fisheries Department of the Scottish Home Office, at which the comprehensive collection of exhibits illustrating many aspects of Scottish fisheries has been supplemented by weekly lectures on a wide variety of fishery topics by recognized experts.

Dr. Douglas A. Allan

MR ROWATT has been succeeded in the directorship by Dr Douglas A. Allan, formerly director of the Liverpool Public Museums. Dr Allan is a graduate of the University of Edinburgh, where he specialized in geology, taking part in the late Dr W. S. Bruce's expeditions to Spitsbergen, and acting as assistant in the University Department of Geology under the late Prof. T. J. Jehu. During 1925-29 he was lecturer in geology in Armstrong College, University of Durham, and in the latter year was appointed director of the Liverpool Museums. Dr Allan has taken an active part in the promotion of museum interests as chairman of the Museums Association and as a member of the Post-War Reconstruction Committee on Museums and Art Galleries. Last year he was awarded the Neill Gold Medal of the Royal Society of Edinburgh for his researches on the geology of the Highland border in Angus and Perthshire.

Biologist to North of Scotland Hydro-Electric Board

AN appointment of more than usual interest to naturalists has been announced by the North of Scotland Hydro-Electric Board, the authority for the development of water-power schemes over a considerable area of the most attractive scenery in Scotland. In 1943 the Board appointed Mr W. L. Calderwood, formerly inspector of Scottish salmon fisheries, as its principal consulting adviser on fishery matters, and will continue in that capacity, but a full-time fishery adviser and biologist, Dr John Berry, has now been appointed to ensure that in the planning of new schemes due attention will be given to all aspects which affect wild life. Dr Berry's wide interests in natural history fit him well for such a post. For some time he was director of the Freshwater Fisheries Research Station at University College, Southampton, and before the War he carried out salmon research for the Fishery Board for Scotland and the Moray Firth Salmon Fishery Company. In 1939 he published for the International Wildfowl

Inquiry an exhaustive volume on "The Status and Distribution of Wild Geese and Wild Duck in Scotland". During the War he has been officer-in-charge of Press censorship in Scotland, but naturalists will welcome his return to his proper vocation.

Royal Society of Edinburgh

Awards

THE Council of the Royal Society of Edinburgh has awarded the Gunning Victoria Jubilee Prize, for the period 1940-44, to Prof. H. W. Turnbull, University of St. Andrews, for his distinguished contributions to mathematical science and the history of mathematics, and the Makdougall-Brisbane Prize, for the period 1942-44, jointly to Prof. Max Born and Dr. H. W. Peng, University of Edinburgh, for their papers on "Quantum Mechanics of Fields" published in the *Proceedings* of the Society within the period of the award.

New Fellows

THE following have been elected ordinary fellows of the Royal Society of Edinburgh: Dr Robert Aitken, lecturer in dermatology, University of Edinburgh; Prof. C. H. Browning, professor of bacteriology, University of Glasgow; Mr A. M. Bryan, mining engineer; Dr William Burns, agricultural commissioner with the Government of India (retired); Dr L. B. C. Cunningham, superintendent of the Air Warfare Analysis Section, Ministry of Aircraft Production; Prof. A. Durward, professor of anatomy, University of Leeds; Dr A. Erdélyi, lecturer in the Department of Mathematics, University of Edinburgh; Dr A. Ghaffar, lecturer in physiology, Robertson Medical School, Nagpur; Dr W. Spence Haldane, teacher of chemistry, Dunfermline High School; Mr E. H. E. Havelock, secretary of the Development Commission; Dr R. E. Illingworth, lecturer on chemistry, School of Medicine, Royal Colleges; Dr John Jardine, principal assistant secretary, Scottish Education Department; Dr D. D. Logan, medical practitioner, Woodside, Lanarkshire; Mr I. S. Macadam, secretary of the Royal Institute of International Affairs; Dr D. M. McIntosh, director of education for the County of Fife; Mr H. P. Morrison, publisher; Prof. J. T. Randall, professor of natural philosophy, University of St. Andrews; Dr James Stirling, lecturer in plant physiology, University of Liverpool; Mr Merion Thomas, reader in plant physiology, King's College, University of Durham; Dr Robert Walmsley, senior lecturer in anatomy, University of Edinburgh; Prof. S. J. Watson, Department of Agriculture, University of Edinburgh, and principal, Edinburgh and East of Scotland College of Agriculture; Mr James Wilkie, secretary of the Carnegie United Kingdom Trust; Mr D. C. Wilson, director of T. and H. Smith, Ltd., Corstorphine; Dr N. C. Wright, director of the Hannah Dairy Research Institute, Ayr; Prof. C. M. Yonge, regius professor of zoology, University of Glasgow.

New Aeronautical Research Establishment

SIR STAFFORD CRIPPS, Minister of Aircraft Production, in reply to a question in Parliament, has stated that it is proposed to build a new research and development centre for both civil and military aircraft construction at Bedford. Many new problems have now to be faced with the approach of supersonic speeds, which will need much special apparatus and

up-to-date wind tunnels. It is intended to make a beginning as soon as possible, but the rate at which the equipment will be provided will naturally depend upon the finance available to meet what will inevitably be a costly project. The transfer of both apparatus and staff from the present Royal Aircraft Establishment at Farnborough will be gradual. Farnborough will eventually be retained for special research and development on armament, instruments and such auxiliary services. It is understood that the new centre will not affect the R A F station at Cardington, but will be an extension of a present American bomber station and the Bedford airport at Thurlleigh.

The adoption of this scheme completes plans that have been under discussion for a long time in the aeronautical world, and is perhaps the widest organization of industrial applied science ever attempted in Great Britain. The experimentation relative to the immediate progress in aircraft design and the solving of problems arising upon aircraft in use will be the province of the designing and constructing firms. At the Royal Aircraft Establishment the Air Ministry, as purchasers and users of aircraft for the Fighting Forces and possibly to a certain extent for air transport, will deal with their special problems, many of which must be handled in this way as necessarily they will be secret. The new organization will deal with long-range fundamental research of a general nature, that will add to the knowledge of all who use the science of aeronautics in any way. This should extend the usefulness of the Aeronautical Research Committee, a body which, acting in an advisory capacity, has been largely dependent upon the goodwill and the capacity of the industry, Government establishments, and the universities, for the carrying out of its suggestions. The importance of this is obvious, and it is hoped that its development will be able to proceed at a reasonably rapid rate.

Royal Commission for the Exhibition of 1851

At the 148th meeting of the Commissioners of the Exhibition of 1851, held on May 6, the Princess Royal was elected president of the Royal Commission in succession to the late Duke of Kent. In his survey of the work of the Board of Management during the period immediately before and after the outbreak of war, Lord Macmillan gave reasons for the partial suspension of the scholarship schemes in 1939, when no fresh awards were made although existing scholarships were continued until their holders were absorbed in the national war effort. So great was the demand for the Commission's experienced research workers and engineering students that by the end of 1940 practically all these men and women had relinquished their awards to take up appointments in the technical branches of the services or in special work for the war industries. Referring to the scientific research awards of the Commission, Lord Macmillan emphasized that the scholarship scheme has produced many of the most eminent men of science in academic, industrial and professional life, including sixty-six fellows of the Royal Society and no less than six Nobel laureates. The Commission's industrial bursary scheme has also been very successful and has helped to place in industry more than six hundred graduates who could not depend on their parents for financial support after their university scholarships came to an end. Sir Robert Robinson described the work of

the Science Scholarships Committee. Since 1921 when the earlier scheme was revised, 90 senior students and 149 overseas scholars from the Dominions have been appointed. The value of the material derived from the Dominions has been more than gratifying. Their records as a whole show that they are using the knowledge and experience gained as scholars to very great advantage in the scientific service of the Commonwealth.

Coasts of England and Wales

A SURVEY of the scenic qualities of the coasts of England and Wales has been made by Mr J. Steers at the instance of the Ministry of Town and Country Planning. The results are embodied in a map accompanying a paper in the *Geographical Journal* of July-August 1944. The greater part of the coastal scenery is classified as of good or very good quality, with exceptional quality mainly in parts of Wales and Cornwall. Comparatively little outside certain industrial areas, has been ruined, but Mr Steers notes the frequent occurrence of bad scattered development marked by huts and bungalows on parts of the East Anglian coast and elsewhere, including, no doubt, coasts in the south-east, an area for the time excluded from the survey. Only a few stretches of coast-line up to the present are under the National Trust, and it is evident that steps will need to be taken speedily not only to check undesirable building, but also to ensure access to the coast-line. Nor must the coast-line be considered in any rigid conception. In many parts it is a zone, and not a coast, that must be protected. Mr Steers argues that the main problems relating to the maintenance of our coast-line from both a scenic and also a physical point of view should be the work of a national organization.

Individual Welfare and Human Progress

THE R A F Penrose Memorial Lecture delivered by the Right Hon. H. B. Butler, British Minister at Washington, has been published (*Proc. Am. Phil. Soc.*, 88, 151, 1944). Mr Butler discusses the lessons derived from the work of the International Labour Organisation during the last twenty-five years. Its organization, he says, has needed little amendment during its first twenty-five years. It was founded in the belief that the welfare of the common man must be one of the main objectives of human society, the supreme aim of which is individual progress. There can be no peace without social justice, nor can we have social justice without peace. War must go, but economic upheaval must also be prevented. The great slump of 1929-33, which was due, not to inability to produce, but to lack of purchasing power, is likely to recur after the present War, to a more serious degree. That slurred taught us that international economic unity is essential. Nations must act together to prevent repetition of it. Wise planning is not enough. There must be a true conception of life as well. The Fascist danger, spread far and wide, will still be a menace after the War, and it will be one of the tasks of the International Labour Organisation, which has been repudiated by all the Fascist States, to fight it. If we follow purely egoistic and materialistic aims and ignore the good of our neighbours, putting economic values above spiritual values, we shall inevitably decline. The cynicism of despair will be equally fatal. B.

we believe that humanity, by its own exertions, attain a higher and nobler destiny than any it has yet known, then we shall not fail.

Overhead Lines and Outdoor Equipment on A.C. Systems

IN a paper read recently in London before the Institution of Electrical Engineers, R C Hatton and McCombe lay down the guiding principles that for an efficient operation, maintenance and testing of electrical equipment in complex A.C. systems, it is of fundamental importance to provide adequate transport and communication systems, a carefully selected and trained staff at strategic points, and centralized control of all operations, and to enforce the strict observance of a suitable code of safety regulations and maintenance of the various components of overhead lines and outdoor sub-stations, which the authors' experience has shown to be necessary or desirable, is detailed, and suitable intervals for such maintenance work are indicated. An analysis of its use is made for both the overhead lines and transformers on the system, and the steps are described which have been taken, or which should be taken, counteracting them. The predominance of faults due to lightning is emphasized and the precautions which can be taken are discussed. Finally, the authors indicate the developments they consider to be desirable to minimize maintenance costs and at the same time to improve the reliability of electricity distribution, with special reference to the system of Yorkshire Electric Power Co.

Institution of Electrical Engineers Scholarships for 1945

THE Council of the Institution of Electrical Engineers will this year consider the award of three arch scholarships and grants, and seven scholarships for undergraduates and students to attend universities and technical colleges. These awards will be made subject to the regulations laid down by the Ministry of Labour and National Service regarding candidates' ages at the commencement of their courses. *Research Scholarships*: Ferranti Scholarship, £100 per annum for two years, Swan Memorial Scholarship, £120 for one year, War Thanksgiving Education and Research Fund, grants up to £100 one year. *Student Scholarships*: Duddell Scholarship, £150 per annum for three years, William die Esson Scholarship, £120 per annum for two years, renewable in approved cases for a third year, Angus Thompson Scholarship, £100 per annum, tuition fees for two years, David Hughes Scholarship, £100 for one year, Salomons Scholarship, £100 for one year, Paul Scholarship, £50 per annum for two years, Thorrowgood Scholarship, £100 per annum for two years. Full particulars can be obtained from the Secretary, Institution of Electrical Engineers, Savoy Place, Victoria Embankment, London, WC2. The closing date for receiving applications is April 15, 1945, and the awards will be made towards the end of June.

Conference on X-Ray Diffraction Analysis

THE X-ray Analysis Group of the Institute of Physics will hold a conference during April 12 and 13, at the Royal Institution, London, under the chairmanship of Sir Lawrence Bragg. The programme includes a lecture by Prof J D Bernal on "The Nature of X-ray Analysis", and a series of papers

on new and improved methods. Discussions are to be included on the equipment of a laboratory for X-ray analysis, the interpretation of X-ray diffraction by optical principles, and the proposal to convert X-ray wave-lengths to absolute values. Further particulars may be obtained from the honorary secretary of the Group, Dr H Lipson, Crystallographic Laboratory, Free School Lane, Cambridge.

Care of Laboratory Animals

THE Universities Federation for Animal Welfare (UFAW), 284 Regent's Park Road, Finchley, London, N 3, has been collecting information for a handbook on the care of laboratory animals. Major C W Hume and Dr F Jean Vinter state that they still require information about maintaining healthy stocks of the larger species—cats, dogs, the smaller ungulates and primates. These species will not be dealt with in detail in the handbook, but references will be given to published accounts of methods of maintaining healthy and contented stocks and a list provided of laboratories at which advice on the subject can be given at first-hand.

Announcements

THE Senatus of the University of Edinburgh has awarded Cameron Prizes for 1945 "for a highly important and valuable addition to Practical Therapeutics" to Sir Alexander Fleming in recognition of his discovery of penicillin, and to Sir Howard Florey in recognition of his work in making possible the clinical application of penicillin.

THE title of professor of chemical pathology in the University of London has been conferred on Dr E J King, in respect of the post held by him at the British Postgraduate Medical School.

PROF DOUGLAS HAY, honorary professor of mining in the University of Sheffield, has been appointed a member of the Board for Mining Examinations in succession to the late Mr Robert Clive.

THE trustees of the Miners' Welfare National Scholarship Scheme, established by the Miners' Welfare Commission for the provision of university scholarships for workers in or about coal mines and their sons and daughters, have appointed Prof J F Duff, vice-chancellor of the University of Durham, to be chairman of the Selection Committee in succession to Sir Franklin Sibly, and Prof W E Curtis, professor of physics at King's College, Newcastle-upon-Tyne, to be a member of the Committee in succession to Prof A M Tyndall.

THE Royal Society of South Africa elected the following to fellowship during 1944: Dr R A Dyer, chief of the Division of Botany and Plant Pathology, Pretoria, well known for work on the Euphorbias, Dr N Sapeika, assistant professor of pharmacology, University of Cape Town, and author of "Actions and Uses of Drugs", and L H Wells, lecturer in anatomy, University of the Witwatersrand, and anthropologist.

ERRATUM In *Nature* of February 24, p 233, Prof Sydney Chapman was wrongly described as "chief professor of mathematics, University of London". Prof Chapman is chief professor of mathematics in the Imperial College of Science and Technology, University of London.

LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications.

A New Vitamin A

AN earlier publication¹ presented evidence which indicated that fish liver oils contain a substance (or substances) which has vitamin A activity but differs in properties from the vitamin A (here designated A₁) previously obtained in crystalline form.² Subsequent research has revealed that the newly recognized compound occurs in fish liver oils in substantial amounts, being responsible for approximately one third of their total vitamin A potency.

We have succeeded in isolating the vitamer* from fish liver oils in pure form. It crystallizes as light yellow needles (m.p. 59–60°) which contrast with the yellow prisms (m.p. 62–64°) of vitamin A₁. It has an absorption maximum at 328 mμ ($E_{1\text{ cm}}^{1\text{ per cent}} = 1675$) while vitamin A₁ has its absorption maximum at 325 mμ ($E_{1\text{ cm}}^{1\text{ per cent}} = 1750$). It is an alcohol which forms a red anthraquinone carboxylate (m.p. 130–131°), while vitamin A₁ yields a corresponding ester which is yellow (m.p. 123–124°). By treatment with alcoholic hydrochloric acid it forms the same anhydro compound (m.p. 76–77°)³ as vitamin A₁, but the reaction proceeds much more slowly. It is more stable to atmospheric oxidation than vitamin A₁.

The constitution of the new vitamer has not yet been definitely established. The available evidence, however, suggests that it may be a geometrical isomer of vitamin A₁ differing in the *cis-trans* configuration at the double bond nearest the hydroxyl group.

A method has been developed for estimating the percentage of the new substance in fish liver oils and concentrates. This is based on the observation that maleic anhydride reacts more slowly with it in benzene solution than with vitamin A₁. Analyses of samples of soupfin shark and dogfish liver oil showed that 30 per cent and 33 per cent, respectively, of the vitamin A was the newly recognized compound.

A second method of estimation of the vitamer depends on the fact that it forms the anhydro compound on treatment with alcoholic hydrochloric acid much more slowly than vitamin A₁. The procedure is less useful than the one just described because it must be carried out on the saponified fish liver oil or concentrate.

A preliminary bio-assay on the new compound has indicated that its potency is nearly the same in kind and magnitude as that of vitamin A₁. More extensive assays are in progress.

The recognition that the vitamin A activity of fish liver oils is due to at least two different substances emphasizes the need for an improved system of nomenclature. The term 'axerophthol' proposed by Karrer for vitamin A₁ has not gained general usage and moreover establishes no basis for naming newly discovered vitamers. The use of subscripts is also unsatisfactory. For example, while the vitamin A₂ found in the liver oils from freshwater fish possesses curative powers for the vitamin A-deficiency

syndrome, it probably has a basically different structural formula than vitamin A₁.

We have consulted various authorities in the United States and have suggested that the A-vitamins in fish liver oils be named from the genus fish in which they were first found or in which they occur in concentrated form. Suggested terms were 'gadol' for vitamin A₁ from *Gadus*, the cod, a 'galol' for the new vitamer from *Gahdæ*, the shark. If other A vitamins are discovered in the future they could be named readily by this system, which is now being considered by the Committee on Biochemical Nomenclature of the U.S. National Research Council.

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Antibiotic Action of an *Aspergillus* Strain against *Mycobacterium tuberculosis**

In the course of investigations on the growth conditions of *Mycobacterium tuberculosis*¹, we have observed that contamination by an *Aspergillus* strain of cultures of *M. tuberculosis* human and bovine type resulted in a distinct inhibition of growth. Systematic experiments founded on this observation led to the preparation of filtrates from pure cultures of the mould, which were active against *M. tuberculosis* human and bovine type. A preliminary report on our results was presented to the Swedish National Society against Tuberculosis on October 1, 1943, in view of a recent communication by M. A. Soltys², which to report briefly our findings.

Our *Aspergillus* strain (the identification of which is not yet completed), when grown on a synthetic medium containing iron-, sodium- and magnesium salts, glycerine and certain nitrogenous substances such as asparagine, at pH 7.2 (phosphate buffer) and at 37° C., produces an antibiotic, which inhibits the growth of *M. tuberculosis* and of *Staphylococcus aureus*. No antibiotic is produced, when the mould is grown on a Czapek-Dox medium. Soltys states that his 'aspergillin' is inactive against *Staphylococcus aureus*, thus, the antibiotic present in our culture filtrates may be different from 'aspergillin'. The chemical properties so far investigated point to the non-identity of our product with the known antibiotics isolated from *Aspergillus* cultures, such as gliotoxin, helvolic acid or patulin. A detailed account of these investigations will be published elsewhere.

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* Swed. Pat. Appl. 7748/43 (6 Nov., 1943).

* The word 'vitamer' was introduced simultaneously by Dean Burke and associates of the National Cancer Institute and workers at Distillation Products, Inc., to indicate two or more substances which have the same ability to cure a single deficiency syndrome.

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Inhibition of Mould Growth by *p*-Aminobenzoic Acid and the *n*-Butyl Ester

In tests conducted in these laboratories, *p*-aminobenzoic acid and the *n*-butyl *p*-aminobenzoate have shown definite reduction in rate of growth of three representative moulds (species of *Aspergillus*, *Penicillium* and *Byssosclamyces*) growing on Czapek-Dox agar medium, pH 4. Inhibition in the case of the acid was very marked (at least 50 per cent) at a concentration of 5.6 millimolar (mm) and a reduction could still be detected, in the case of *Aspergillus*, as low as 0.18 mm. The butyl ester proved more effective, greater than 70 per cent reduction being observed at 1.0 mm and a marked effect persisting down as low as 0.14 mm—the lowest concentration tested. In cases of the intermediate and lower concentrations of the free acid, the colonies remained regular in outline and maintained a steady though reduced rate of increase, concentrations 9.8 and 5.6 mm gave rise to very irregular and fluctuating growth. With higher concentrations of both substances, particularly of the *p*-aminobenzoic acid, an orange-brown pigmentation was observed both in the central felt and in the surrounding medium.^{1,2} With interest largely focused on the anti-sulphonamide and growth-factor effects of *p*-aminobenzoic acid and the fact that these are shown at extreme dilutions, it is not surprising that observations of inhibition by this substance have been relatively few. Woods³ has actually referred to a slight inhibition of bacteria at concentrations (unspecified) above 1 mm. Most workers have been concerned with lower maximum concentrations than this, although Meyer² does not report inhibition of *Mycobacterium tuberculosis* when working at concentrations as high as 7.3 mm. Tamura⁴ has, however, found inhibition of *Bacterium tularensis* at 0.5 mm and complete inhibition of growth after eight days at 1.0 mm. Johnson *et al.*⁵ found evidence of both stimulation and inhibition of luminescent bacteria according to the concentration of *p*-aminobenzoic acid in the different parts of the treated growth. Lee and Foley⁶ have made the interesting observation that raised temperatures can cause inhibition of bacterial growth by *p*-aminobenzoic acid at concentrations as low as 1 mm, as well as failure to show anti-sulphonamide action. Lavor and Ferguson⁷ record harmful effects on protozoa by concentrations of *p*-aminobenzoic acid (7.3–0.073 mm), comparable with those reported above as effective against moulds. Esters of *p*-aminobenzoic acid have also been recorded principally from the point of view of growth factor and anti-sulphonamide activity. These include simple alkyl esters^{8,9} and local anaesthetics of the same type^{10,11,12}. Kuhn *et al.*⁹ include some results with such esters. Their experience of the butyl ester differs from ours with fungi, in that they report it, together with the ethyl, lauryl and cetyl esters, as having no bacteriostatic effect with *Streptobacterium natarum* when studied up to approximately 12 mm. It is would, according to our experience, be at least in excess of the solubility of the butyl ester. Other compounds related to *p*-aminobenzoic acid could be mentioned. Both Hirsch¹³ and Kuhn *et al.*⁹ have reported inhibition by *p*-aminobenzamide, the former found it almost as active as sulphanilamide at comparable concentrations, the latter noted growth accelerations at greater dilutions (0.007 mm) but

50 per cent inhibition at 0.014 mm. Auhagen¹⁴ reports relatively weak sulphonamide-like inhibition with *p*-aminoacetophenone and *p*-aminobenzophenone. Other workers^{15,16} have studied a number of substituted *p*-aminobenzoic acids, and have found that according to the nature and position of the substituents, some of the compounds demonstrated sulphonamide-like bacteriostasis, some retained *p*-aminobenzoic acid properties, while others were practically inactive.

Such results as those reviewed above, taken with our own experience with moulds, suggest that more attention might be given to the inhibitory action of *p*-aminobenzoic acid and its derivatives. On one hand, increasing the concentration of *p*-aminobenzoic acid gives rise to definite inhibition. On the other, stimulation by sulphanilamide has been observed in low enough concentrations^{5,17}. Compounds like sulphanilamide and *p*-aminobenzoic acid might profitably be regarded as members of the same broad biochemical group possessing a similar 'pattern' of inhibitory properties, showing quantitative rather than qualitative differences in their toxic behaviour.

Evidence of its toxic properties raises the question as to the form in which *p*-aminobenzoic acid is likely to occur in the cell. It seems probable that some at least is built into a larger 'non-toxic' molecule. Recently the existence of 'bound' forms of *p*-aminobenzoic acid in naturally occurring material has been postulated^{18,19,20}. According to Blanchard's evidence²⁰ the amino group is likely to be involved in a peptide link. Ratner and others are reported²¹ as having isolated from yeast a polypeptide containing one molecule of *p*-aminobenzoic acid and some thirteen molecules of *l*-(+)-glutamic acid.

Further systematic investigations of *p*-aminobenzoic acid and related compounds are being conducted in these laboratories.

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Production of Kojic Acid by *Aspergillus effusus* Tiraboschi

IN 1942 Wilkins and Harris¹ reported that culture media on which the mould *Aspergillus effusus* Tiraboschi (National Collection of Type Cultures, No. 973) had grown inhibited the growth of *B. coli* and *Staph. aureus*. It has been found that, under cultural conditions to be described, the whole of the antibacterial activity can be attributed to the production of kojic acid. Owing to the weakness of its antibacterial properties this substance is not generally regarded as an antibiotic, its detection as such was due to its relatively high concentration in the culture fluid. Attention is directed here to kojic acid as an antibiotic because it is a common product of mould metabolism and may account for the inhibitory properties of a number of moulds not yet investigated in detail. Recognition of this possibility may prove time-saving to other workers.

Kojic acid is stated by Yabuta² to be produced in a high yield from various carbohydrate sources by *Aspergillus oryzae*, *albus*, *candidus* and *nidulans*. It was obtained by Birkinshaw *et al.*³ from *Aspergillus parasiticus* and *Penicillium daleae* Zaleski. The latter authors deduced its production also by *A. effusus* Tiraboschi, *A. tamarii* and *A. flavus* from the production of a strong wine-red colour on treating the crude medium with ferric chloride, but it should be noted that the mould products claviformin (produced by at least four fungal species) and aspergillilic acid give a similar red colour with ferric chloride. The literature of kojic acid, up to 1934, has been reviewed by Barham and Smits⁴, who mention its antibacterial properties.

The mould was grown at 24°C in Erlenmeyer flasks on a medium of the following composition: maltose 40 gm, peptone 10 gm, malt extract 26 c.c., water 1 litre. The antibacterial activity of the medium, measured by the plate and cylinder method against *Staph. aureus*, reached a maximum at 12–14 days, thereafter diminishing rapidly. At that time yields of kojic acid averaged 8–9 gm per litre.

Tested by the dilution method, kojic acid completely inhibited the growth of a strain of the following bacteria at the concentration shown:

> 1	400	< 1	800	<i>Proteus</i> , <i>Salm. enteritidis</i> , <i>Bact. coli</i>
> 1	800	< 1	1600	<i>Salm. typhi</i> , <i>Staph. pyogenes</i> .
> 1	1600	< 1	3200	<i>Ps. pyocyanea</i> (2 strains)
> 1	3200	< 1	16400	<i>Ps. pyocyanea</i> (2 strains)

Unlike that of many other antibacterial substances, its potency was little affected by the number of bacteria present. A thousandfold increase in the size of the inoculum made little or no alteration in the inhibitory titre. Neither was the antibacterial activity reduced after incubation for three hours at 37°C in 50 per cent serum.

For testing toxicity to animal tissues, solutions of kojic acid were neutralized with sodium hydroxide to pH 6.8 (which does not diminish the antibacterial activity of the solution). The toxicity to cells *in vitro* was estimated by its effect on human leucocytes⁵. In a 1:100 solution the cells became sluggish or stationary in half an hour and were nearly all dead in three hours. In 1:200 the movement of the majority was arrested in two hours but the cells did not die. The preparation in 1:400 did not differ significantly from control preparations. Dr R. W. Ross informs us that a 1:400 solution did not interfere with phagocytosis by human leucocytes.

Sodium kojate produced characteristic signs when

injected into mice by any route in a sufficiently large dose. The mouse became prostrate, the legs and tail stretched out stiffly and the breathing slow and laboured, the coat was not roughened. After the largest doses there was slight irregular twitching of muscle groups and a lethal dose produced convulsions before death. The duration of sickness was proportional to the size of the dose, and even after prostration lasting for two or three hours, recovery, if occurred, was rapid and complete.

Friedemann⁶ described similar effects on dog rabbits and rats, and gave the toxic dose (intravenous) as 150 mgm per kgm and the lethal dose as 1 gm per kgm. The figures for mice are of the same order. In mice weighing from 20 to 23 gm 5 mgm injected subcutaneously, intraperitoneally or intravenously usually produced signs of toxicity, at 30–40 mgm killed, by mouth 20 mgm was without effect, 40 mgm produced illness and 80 mgm killed.

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A Twenty-four Hour Pregnancy Test for Equines

IN 1928 the Aschheim-Zondek Test for the diagnosis of human pregnancy in urine was introduced¹. In 1930, B. Zondek proposed a modification of this test for the diagnosis of equine pregnancy in the blood and in the urine². The blood test is only feasible, however, between the 42nd and 125th days of pregnancy, after which the equine gonadotropin disappears from the blood³.

These pregnancy tests are based upon the gonadotropic reactions which have been classified (1926–5) as follows⁴:

Anterior pituitary reaction, I	oestrus reaction in the mouse and hyperaemia in the rat ovary, follicle hæmorrhage in the ovary of mouse and rabbit (blood dot)
Anterior pituitary reaction, II	corpus luteum formation in ovary of mouse, rat and rabbit
Anterior pituitary reaction, III	

Most characteristic is the follicle hæmorrhage appearing (as anterior pituitary reaction II) in the ovary of the mouse and rabbit, which has since been used for the diagnosis of pregnancy in man and equine. The reliability of pregnancy tests, based upon the gonadotropic reaction, is about 99 per cent. The only disadvantage of these tests is the long reaction time required: 6 days for the rat, 5 days for the mouse and 2 days for the rabbit.

It has recently been demonstrated that a reliable diagnosis of human pregnancy may be carried out within twenty-four hours, using the hyperaemic reaction of the infantile rat ovary (anterior pituitary reaction II). The test is based on the fact that within twenty-four hours (sometimes even two to six hours following the injection of human pregnancy urine) the ovaries of the infantile rat undergo a structural

peræmic reaction, accompanied by swelling, as already described in 1927⁴. This is the earliest stage gonadotropic reaction following the injection of gonadotropic hormone. It seemed possible that the pid method as applied to the urine of pregnant men might be applicable as well to the blood of egnant mares. In the latter, the diagnosis of early egnancy by a veterinarian is difficult, and on the her hand it is important to the breeder to recognize egnancy in its early stage in order to prevent ortion due to excessive work or strain.

The first thing to be established was whether the peræmia test is evoked by pregnant mare blood nadotropin as it is by human pregnancy urine nadotropin. The clarification of this point was of portance, as pregnant mare blood contains mostly e follicle-stimulating hormone and human pregnancy ne contains chiefly the luteinizing factor. We ind the hyperæmia test to be quite sensitive for e detection of minute amounts of human pregnancy ne gonadotropin, 1 hyperæmia unit (anterior utary reaction II) equalling 1 œstrus unit (anterior utary reaction I). Unfortunately, the hyperæmia st (anterior pituitary reaction II) is not so sensitive e the detection of small amounts of pregnant mare od gonadotropin, 1 hyperæmia unit (anterior utary reaction II) equalling as much as 10 œstrus its (anterior pituitary reaction I) and 3 luteiniza- n units (anterior pituitary reaction III) of preg- nt mare blood gonadotropin. The new method ures, therefore, 3-10 times the amount of hor- me administered in the earlier pregnancy test² for unes, but it has the advantage of giving clear-cut ults with 99 per cent reliability within twenty-four rs. It is possible to obtain a positive reaction h the hyperæmia test as early as 4-6 hours after ection of the equine gonadotropin. The reaction his early stage is positive, however, only in 33-50 cent of the animals, and whereas the positive re- ion indicates pregnancy, negative results cannot be luated. Furthermore, the faint pink colour of ovary, obtained after 4-6 hours, is not so con- eing as the dark red appearance after 12-24 hours efore, we prefer the 24-hour pregnancy test

Technique The mare or donkey is bled from the ular vein and 20 c.c. serum are sent to the labo- tory. If the specimen is sent through the post ew drops of phenol or preferably tricresol should added to the serum. In the laboratory four rats eeks old, 30-40 gm. in weight are injected as ows

R 1	20 c.c.	} twice daily, preferably at 2-4 hr intervals
R 2	15 c.c.	
R 3	10 c.c.	
R 4	0.5 c.c.	

1 is killed on the evening of the day of the first injection at least us after the first injection and 4 hours after the second injection 2 and R 3 are sacrificed on the following day, about 18-24 hours e the first injection.

4 is sacrificed 5 days after the first injection, after having received 0.5 c.c. serum for 4 consecutive days, that is, a total of 4 c.c. m

The test is positive if at least both ovaries of one he rats R 1-3 show a distinct red colour resembling t of the spleen or kidney. As a rule, all the rats t similarly. Autopsy of rat R 4 takes into con- ration vaginal œstrus and corpus luteum forma- : as in the original Aschheim-Zondek test and es for control purposes only. It detects all cases arly pregnancy or late pregnancy where the blood adotropin titre is lowered.

The hyperæmia test gives positive results with all e containing more than 250 IU pregnant mare

blood gonadotropin per litre. It may also be used for quantitative pregnant mare blood gonadotropin de- terminations since 1 hyperæmia unit, that is, the smallest quantity of serum evoking the rat anterior pituitary reaction II, equals about 1 IU. It facilitates the preparation of pregnant mare blood gonadotropin by making possible the bleeding of pregnant mares at the peak of hormone production.

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A New Type of Phase Rule Solubility Test for Enzyme Purity

IN 1937 Kuhn and Desnuelle¹ prepared a highly purified specimen of Warburg's yellow enzyme, and as evidence of purity they pointed out that when ammonium sulphate was added to the solution the yellow colour and the protein began to come out of solution at the same salt concentration, and that the decrease in yellow colour and the decrease in protein content were parallel. They did not develop the test further, nor did they successfully apply it to the analysis of impure solutions.

From the work of Butler, Blatt and Southgate², Roche, Doriot and Samuel^{3,4}, and Jameson and Roberts⁵, it is clear that when increasing quantities of a precipitating salt are added to a series of protein solutions, the appearance of a new solid phase will cause a break in the curve relating concentration of protein in solution to salt concentration. Further, Jameson and Roberts pointed out that such breaks in continuity were in accordance with the phase rule.

It is the object of this account to show that an analysis of the effect of increasing quantities of a precipitating salt on a protein solution can be used as a purity test for any protein with an accurately measurable specific quality.

The enzyme solution used in these studies was a highly purified solution of pig liver esterase, and the precipitating salt was ammonium sulphate. Increasing quantities of salt were added to equal volumes of enzyme solution, and after precipitation had ceased the solutions were filtered and the filtrates analysed for enzyme and for protein. The test consists in plotting these latter quantities against one another and analysing the result.

From the work of Cohn⁶, we would expect a linear relationship between log solubility and ionic strength. It is therefore interesting to note that when plotted logarithmically, there is a double inflexion in the enzyme precipitation curve (graph 2), indicating the presence of two esterases the solid phases of which behave independently.

We can interpret graph 5 somewhat as follows. The fall in enzyme activity between A and B occurred before any protein precipitation took place, and is therefore probably due to denaturation on the air bubbles salted out by the ammonium sulphate. At B

the solution is saturated with respect to an impurity and the protein concentration decreases without any change in enzyme concentration to C , where the solution becomes saturated with respect to the enzyme. Between C and the origin the concentration of the impurity decreases with respect to that of the enzyme and the curve gradually straightens. The inflexion due to the precipitation of the second enzyme does not occur, probably because the activities of the two enzymes expressed as enzyme units per milligram of protein nitrogen are too close to show as a difference in slope.

If we assume Cohn's equation⁶ and let S_I and S_E , β_I and β_E , and k_I and k_E , be the solubilities, intercept constants, and slope constants of the impurity and of the enzyme respectively, and if I be the ionic strength, we have

$$\log S_I = \beta_I - k_I I \quad (1)$$

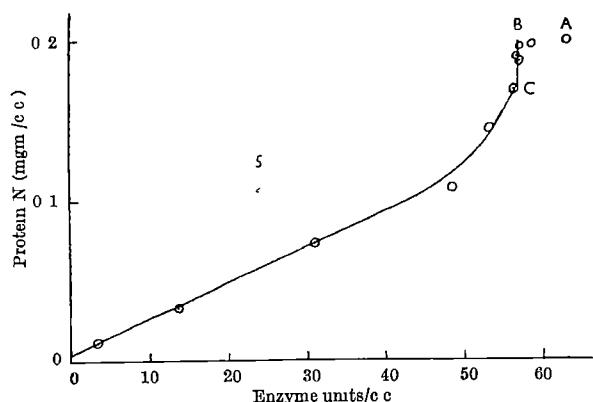
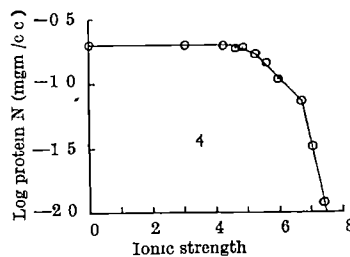
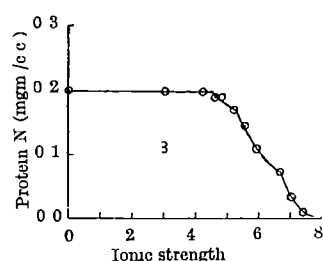
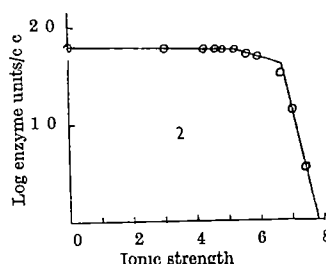
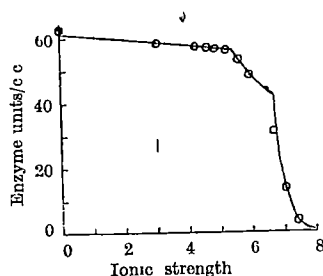
$$\text{and } \log S_E = \beta_E - k_E I \quad (2)$$

$$\therefore S_I = e^{(\beta_I - k_I I)} \quad (3)$$

$$\text{and } S_E = e^{(\beta_E - k_E I)} \quad (4)$$

Now since the protein concentration P at any point on graph 5 between C and the origin is equal to the sum of the protein solubilities, the equation to graph 5 must be

$$P = e^{(\beta_I - k_I I)} + \frac{1}{K_E} e^{(\beta_E - k_E I)} \quad (5)$$



where the conversion constant K_E is equal to the activity of the pure enzyme expressed as enzyme units per milligram of protein nitrogen.

Equation 5 expresses the relationship between the enzyme and the impurity, and can be used to calculate the subsequent purification procedure.

It is clear that in the case of a pure substance graph 5 would be a straight line passing through the origin.

It is a pleasure to express our indebtedness to both Dr G S Adair and Dr D W G Style for their invaluable advice on many points.

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Structure of the Photon

By analogy with the existence of both positive and negative electric charges, one may envisage the possibility of the existence of negative as well as positive mass. The non-appearance of such particles can be readily explained, but in at least one case the hypothesis leads to useful deductions.

Consider a particle of mass and charge both equal to those of the electron, but opposite in sign. In free space the behavior of a doublet consisting of an electron and this particle (termed provisionally the a-tron) shows considerable similarity to that of a photon.

When the electron and a-tron coincide there is no resultant charge or mass, no internal effects are observed and to all intents and purposes the doublet is non-existent. If the two particles are separated by a suitable amount of energy a force of attraction arises which accelerates the electron towards the a-tron, and the latter away from the electron (due to its negative mass). The doublet as a whole travels forward with a limiting velocity the velocity of light. The separation of the two particles determines the energy E of the doublet, but not its velocity.

The 'effective' mass M of the doublet in motion is determined by its energy E ,

$$m = E/c^2$$

Its momentum p ($p = E/c$) can be lost in part on collision with matter (Compton effect), with changing the limiting velocity c .

In free space the doublet behaves as a unit, the presence of a positive gravitational mass it accelerated bodily towards the latter. It cannot be subdivided without losing its fundamental properties and this property it shares with the photon.

To a stationary observer the emission of a doublet by a moving body results in a change in wavelength due to the 'carry-on' of the electron, which is emitted after the emission of the a-tron (Doppler effect).

On interaction with matter, the doublet may appear as a unit, for example, the a-tron may

neutralized by an electron, thereby freeing the electron constituent of the doublet, together with a corresponding amount of energy (photo-electric effect)

The electromagnetic wave properties of the photon are paralleled by those of the probability waves of the doublet. The close analogy between them is demonstrated, for example, by the similarity in the laws of interference of electronic probability waves and of electromagnetic waves (electron and X-ray diffraction)

A photon of energy E has a wave-length $\lambda_p = hc/E$. A doublet of this energy has a de Broglie probability wave-length $\lambda_b = h/mc = hc/E$ (from equation 1). Thus the de Broglie probability wave-length of the doublet equals the electromagnetic wave-length of the photon in free space. Similarly, the velocity of the de Broglie waves ($u = c^2/v = c$) equals that of light. In a medium of refractive index other than unity this conclusion requires modification.

In free space the doublet can thus be represented by a sinusoidal probability wave, of wave-length λ and travelling with velocity c . The square of its amplitude at any point is proportional to the charge and mass at that point.

The electric and magnetic fields associated with the photon arise, not from this sinusoidal variation in electric charge, but from the magnetic moment due to electron (and a-tron) spin. At rest, the magnetic moments of electron and a-tron coincide and neutralize one another. In motion it is assumed that they are perpendicular to the direction of motion. At any point the sinusoidal variation in electric charge density gives rise to a corresponding variation in the magnetic moment (which is proportional to it), and hence to that of both magnetic and electric fields.

The direction of magnetic moment of the doublet may be indeterminate around the axis of propagation. It may be parallel to a given direction, etc. In the first case, the waves are unpolarized, in the second they are linearly polarized. Corresponding to the laws relating to the polarization of light are those relating to the spin of the electron and a-tron. Further consideration of a duality of positive and negative masses appears capable of furnishing information on the nature of the electric field.

A. CHARLESBY.

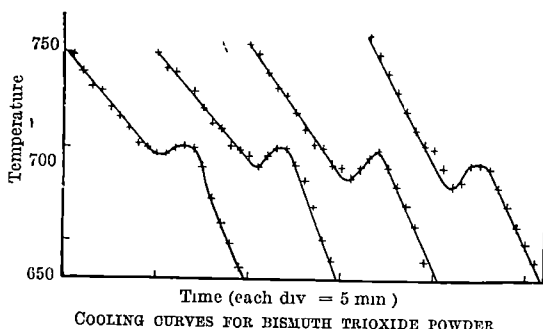
Headquarters,

Mediterranean Allied Air Forces, C M F.

Dec 23

Polymorphism of Bismuth Trioxide

From thermal analyses, Guertler¹ concluded that bismuth trioxide, Bi_2O_3 , existed in two forms, one stable above 704°C and one stable below this temperature. He was not able to prepare the high-temperature modification even by quenching. From the smoke of burning bismuth, Sillén² prepared a second form of bismuth trioxide, which was proved by X-ray analysis to be different from the ordinary form. This new phase was called $\beta\text{-Bi}_2\text{O}_3$ and the ordinary form $\alpha\text{-Bi}_2\text{O}_3$, and it was assumed that $\beta\text{-Bi}_2\text{O}_3$ corresponded to Guertler's high-temperature form. Schumb and Rittner³ have also prepared β -form and shown that it is transformed to the α -form below 710° . However, they believe that the transitions $\alpha\text{-Bi}_2\text{O}_3 \rightarrow \beta\text{-Bi}_2\text{O}_3$ and $\beta\text{-Bi}_2\text{O}_3 \rightarrow \alpha\text{-Bi}_2\text{O}_3$ are rather slow reactions, and that the transition



point observed by Guertler was quite a different phenomenon, due to contamination of the molten oxide by the crucible employed.

Now if bismuth trioxide is heated to above 700° in a crucible of a resistant material and then allowed to cool, the mass is first seen to darken and then suddenly to glow, which strongly indicates the presence of a transition point. We have tried to investigate this transition under such conditions that contamination was practically excluded. A rather large quantity of pure bismuth trioxide was heated (in a platinum crucible) for about thirty minutes to below its melting point. The temperature was measured by means of a thermocouple inserted directly in the mass. The cooling curve very clearly shows a transition point at about 700° (see accompanying graph). Since the careful work of Schumb and Rittner has shown that the transition point of $\beta\text{-Bi}_2\text{O}_3 \rightarrow \alpha\text{-Bi}_2\text{O}_3$ is at about 710° , our experiments appear to indicate, in accordance with Guertler's, that the transition is more rapid than Schumb and Rittner have suggested.

When Guertler fused bismuth trioxide in a porcelain crucible, he obtained a new substance which he considered to be a third modification of the trioxide. Sillén also prepared this substance and found that it was isomorphous with a synthetic compound with a body-centred cubic cell containing $\text{Si}_2\text{Bi}_{12}\text{O}_{40}$. The latter seems to be built up by spheres of composition $\text{SiBi}_{12}\text{O}_{20}$ with Si in the centre. Similar compounds were prepared from Bi_2O_3 and Al_2O_3 or Fe_2O_3 . Their composition may be $\text{Me}_2\text{Si}^{3+}\text{Bi}_{12}\text{O}_{39}$.

Schumb and Rittner have prepared a third form of bismuth trioxide called by them $\gamma\text{-Bi}_2\text{O}_3$. Powder photographs and density measurements indicated a body-centred cubic cell containing $\text{Bi}_{12}\text{O}_{39}$. Though this cell is very similar to the body-centred cubic cell determined by Sillén, Schumb and Rittner do not consider the crystal structure to be the same. They hold that the differences in ionic radii between Bi^{3+} and the Me ions in $\text{Si}_2\text{Bi}_{12}\text{O}_{40}$ and similar compounds is too large to allow Bi^{3+} to be substituted for the Me ions.

We have prepared the $\gamma\text{-Bi}_2\text{O}_3$, following the method of Schumb and Rittner. Their analyses did not entirely exclude the possibility that some of the bismuth is pentavalent, and the formula $\text{Bi}_{12}\text{O}_{40}$ did not seem improbable by analogy with $\text{Si}_2\text{Bi}_{12}\text{O}_{40}$. We therefore analysed for Bi^{5+} , but within the limits of error we found none. Consequently, the unit cell of $\gamma\text{-Bi}_2\text{O}_3$ probably contains $\text{Bi}_{12}\text{O}_{39}$. Since the work of Sillén, Aurivillius has investigated a number of metal bismuth oxides seemingly isomorphous with $\text{Si}_2\text{Bi}_{12}\text{O}_{40}$. A summary is given below. Hitherto no mono- or divalent ions have been found to enter the central positions of Si^{4+} . The table shows that the lattice dimensions grow larger when the Si^{4+}

ions are replaced by larger cations and that even Ce^{4+} can be substituted for Si^{4+} . Unlike Schumb and Rittner, we therefore think that even Bi^{3+} can enter the central positions, though this will imply only fourfold co-ordination of oxygen ions around the central bismuth ions. As the unit cell of $\gamma \text{Bi}_2\text{O}_3$ contains 39 oxygen atoms, it is necessary to assume vacancies in the oxygen lattice.

Cube edges of various Me-Bi-O compounds of type $\text{Si Bi}_2\text{O}_{10}$

Metal	a (Å)	Ionic radius of metal (Å)
Al^{3+}	10.14	0.53
Ti^{3+}	10.15	1.00
Fe^{3+}	10.16	0.67
Bi^{3+}	10.243	1.0
Si^{4+}	10.08	0.40
Ce^{4+}	10.20	1.02
Zr^{4+}	10.21	0.83
Pb^{4+}	10.23	0.84

BENGT AURIVILLIUS
LARS GUNNAR SILLÉN

Institute of General and
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Stockholms Hogskola.

¹ Guentler, W., *Z. anorg. Chem.*, **37**, 222 (1903).

² Sillén, L. G., *Ark. Kem. Min. Geol.*, **12**, A, No. 18 (1937) and Diss. Stockholm (1940).

³ Schumb, W., and Rittner, E., *J. Amer. Chem. Soc.*, **65**, 1055 (1943).

Bottom Deposits of the Red Sea

DURING the Egyptian Preliminary Expedition to the northern Red Sea in the R.R.S. *Mabaluth* during 1934-35, which I accompanied, some sixty bottom-samples were collected, in particular from the three differently constituted areas, the Gulf of Suez, the Gulf of Aqaba and the Red Sea proper^{1,2}. The mechanical composition and mineralogy of the bottom sediments were recently examined in the Department of Geology, Faculty of Science, Cairo.

The Red Sea is unique among the seas of the world in the fact that no permanent streams flow into it, and that only winds, mostly north-westerly, and occasional rain-torrents contribute material to its bottom. The sea is probably unique also for the very irregular bottom topography (excluding the Gulf of Suez), hence the nature and distribution of its bottom deposits are unmatched in other seas.

The sediments are coarser and better sorted, when they are secured from shallow or sloping bottoms (being finer in basins than on ridges and slopes) or from near land masses (including submarine ridges)³. The topography of the bottom seems to be the important factor in determining the physical constitution of the deposits. The irregular topography of the bottom gives rise to variety in the sediments. Contrasts appear between the deposits of the shallow and smooth Gulf of Suez, the deeper Gulf of Aqaba and the very irregular Red Sea proper. The Gulf of Suez, because of its flat bottom, has deposits with but little variation in their statistical data, in contradistinction with deposits on the very irregular bottom of the Red Sea, which have rapid changes in the corresponding statistical constants. The difference in environment is also shown by the fact that the sediments of the Gulf of Suez, though of shallow origin, are finer and less sorted than those of the Gulf of Aqaba or the Red Sea shallow environments. The peculiarity of the Gulf of Suez is also reflected in the mineralogy of its sediments, which are much richer in authigenic pyrites than either the Gulf of

Aqaba or the Red Sea. The Gulf of Suez sediments are, in fact, comparable with normally sorted sediments from continental shelves, the Gulf of Suez is itself a shallow flat shelf filled with surface water of the Red Sea and descending at its mouth abruptly to a depth five times greater than its own. It is to be noted that the chemistry of the bottom deposits showed contrast in the three main regions investigated⁴.

The mineralogy of the sediments is uniform over the different provinces and thus contrasts with that of the usual basins of deposition. Local variations are, however, caused by contamination from local source rocks or variation in the environmental conditions of deposition⁵. Such uniformity in the mineralogy of the Red Sea bottom sediments, which are mainly carried by wind, and the absence of sedimentary petrographic provinces, are the main characteristics of wind-borne detritals. The conclusion of Sujkowski, who examined bottom deposits from the middle and south-eastern parts of the Sea, that the characteristic of the deposits, because of the absence of any chemical decomposition and lack of water transportation, is the presence of the easily weathered, coloured minerals and the common rock-forming minerals of crystalline rocks in abundance in a fresh state⁶, are invalid as he overlooked the factor of provenance. The recent dunes of the great African Sahara, where conditions that favour mechanical disintegration rather than chemical decomposition of source rock prevail, but where sediment and not crystalline rocks dominate, contain a totally different assemblage (poor in the common rock-forming minerals: pyroxenes, amphiboles, micas and feldspars) from that of the Red Sea⁷. On the other hand, the Nile sediments, which are water-borne, gave an assemblage of minerals with the same characteristics as those of the Red Sea bottom deposits. Both formations, though of two different modes of origin, are remarkable examples of the richness of recent sediments (derived from crystalline rocks) in vulnerable minerals. The statement of White⁸ that the wind-borne sands contain less frequent heavy minerals than water-borne sands, and that the heavy minerals are less frequent in larger deserts than in smaller desert areas, is invalid as he did not take into account the factor of provenance in this case also.

The mineral assemblage of a sediment depends, in fact, on the following three main factors, which should be collectively taken into account when the nature of the assemblage is to be explained: (1) nature of distributive rocks, (2) type of weathering and mode of transportation, (3) post-depositional processes, leading to simplification of detrital grains¹.

The mineralogy of the clay fractions of the bottom deposits is, at present, under investigation.

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¹ Crossland, C., *Nature*, **137**, 712 (1936).

² Crossland, C., *Pub. Marine Biol. Station, Ghardaqa (Red Sea)*, **1**, (1939).

³ Shukri, N. M., and Higazy, R. A., *J. Sed. Petrology*, **14**, 43 (1944).

⁴ Mohamed, A. F., *Proc. Roy. Soc. B*, **123**, 306 (1940).

⁵ Shukri, N. M., and Higazy, R. A., *J. Sed. Petrology*, **14**, 70 (1944).

⁶ Sujkowski, Z., *Geol. Mag.*, **69**, 311 (1932).

⁷ Bellair, P., *C. R. Acad. Sci. (Paris)*, **207**, 1054 (1938).

⁸ Shukri, N. M., *Geol. Mag.*, in the press.

⁹ White, W. A., *Amer. J. Sci.*, **237**, 742 (1939).

¹⁰ Boswell, P. G. H., *Nature*, **147**, 734 (1941).

IDES OF THE ATLANTIC OCEAN

PROF J PROUDMAN, professor of oceanography in the University of Liverpool, delivered the George Darwin Lecture at the Royal Astronomical Society on October 13, 1944, the subject of his lecture being "The Tides of the Atlantic Ocean" (*Ion Not Roy Ast Soc*, 104, 5, 244, 1944).

Prof Proudman gave a short history of the problem, starting with Whewell, who published the first tidal charts in 1833, which were based on reasoning of a largely non-dynamical character. Whewell's intuitions that the tides of the Atlantic were generated in the Southern and Pacific Oceans, which were rejected and which Whewell himself had abandoned by 1848, continued, unfortunately, to be treated for a long time in text-books. In 1874 Ferrel calculated, on dynamical principles, what the tides would be in canals along parallels of latitude stretching from one side of the Atlantic to the other.

He thought that there might be an approach to conditions of resonance for a canal between Ireland and Newfoundland, and if a dyke extended from the Cape of Good Hope to the coast of South America, the tides in the North Atlantic would probably be very nearly the same as they actually are. In 1900 Morris took up Ferrel's work, and four years later instructed charts of co-tidal lines for all the oceans were issued, but as Proudman points out, his work involved a number of serious errors, among which may be noticed a mathematical mistake involving an error of three hours in the times of high water, the neglect of the resonance of transverse oscillations for the North Atlantic, lack of consideration of the effect of water in neighbouring regions, and failure to give adequate consideration to the dynamical effects of earth's rotation.

In 1910 Poincaré discussed the energy implications of progressive waves, and in applying his principle of the influx of energy into any region and the forces which must balance it, he concluded that, for the arctic seas, the dissipation of energy by the friction of tidal currents on the sea bottom was always negligible, that the work done against the separating force was also negligible, and that the loss of energy out of the region was insignificant on account of the smallness of the Bering Strait. He therefore deduced that the arctic tides do not consist of a wave progressing from the Atlantic, but, as Ferrel showed in 1918 and Jeffreys in 1923, friction is by no means negligible in shallow seas, and Poincaré's arguments could not be maintained.

A brief reference is made to Sterne's co-tidal lines, which are not based on dynamical principles, but on observation, and then Defant's work is considered at length. Defant abandoned his work of 1914 and confined his attention to the neighbourhood of the central line of the ocean and also to part of the Atlantic south of Iceland. He started assuming that the rotation of the earth does not affect the tidal conditions on the central line, that the transverse generating forces do not affect tidal conditions on the central line, and that there is no dissipation of energy to the south of Iceland. He considered two phases, differing by a quarter period, such that they agree with observations at the Azores and Tristan da Cunha, the node of one phase coinciding with the loop of the other, and his results were in good agreement with the observations on these islands. Although Defant's assumptions cannot be regarded as anything more than rough approxima-

tions, conditions on the central line can be largely accounted for by means of longitudinal oscillations.

Prof Proudman then turned to the results of his own researches, which are purely dynamical and are concerned with a study of a region of the Atlantic bounded by two parallels of latitude, those of 45° N and 35° S. He supposes that we are given either (1) the general conditions to be satisfied along the coasts and the actual meridian-components of currents across the bounding parallels, or (2) the general conditions to be satisfied at the coasts and the actual tidal elevations on the bounding parallels, or (3) the general conditions to be satisfied at the coasts and the actual meridian-components of the currents on one bounding parallel and the actual elevations on the other bounding parallels. Then the tidal elevations and currents are mathematically determinate all over the region considered, including their values on the coasts. As we do not know the actual currents or the actual elevations or the bounding parallels, but we know the coastal elevations, the problem is considered the other way round. Given the general conditions along the coasts and the actual values of coastal elevations, the tides are mathematically determinate over the whole region considered, and Prof Proudman solves the problem by considering a number of subsidiary problems of a different type, but limits of space prevent a detailed account of these, and a short summary of his work must suffice.

Selecting the parallel of 35° S as the one along which certain conditions are prescribed, and taking the elevations and meridian components of current to be zero along this parallel, but allowing for all the generating forces, one particular solution is obtained. While the resulting oscillation is small in the South Atlantic, there are larger amplitudes in the North Atlantic, and a large co-tidal area exists here. A second particular solution is an oscillation which Prof Proudman calls a north-going Kelvin-wave, and corresponds to currents along the meridians and to elevations, both of which increase exponentially towards the west. Considerable complications are produced by the curvature of the earth along the meridians, by variations in the width of the oceans and by variations in depth. A third solution gives a south-going Kelvin-wave, and again the currents in latitude 35° S are along the meridian, but in this case both the elevations and currents increase exponentially towards the east. By assuming that the transverse currents follow a sine-distribution from coast to coast, two other solutions, called the north-going and the south-going Poincaré-wave, are obtained, and in these cases the amplitudes are small in the centre of the ocean.

The problem is to assign an amplitude and a time-origin to each Kelvin- and Poincaré-wave, so that when the four are added to the forced oscillation, the coastal elevations in the synthesis will agree with observations so far as possible. Prof Proudman has made the sum of all the waves agree with observation at four points on the coasts, and he has chosen two of these points in latitude $32^{\circ} 5' S$ and the other two in latitude $7^{\circ} 5' S$, that is, south of the Gulf of Guinea and Cape San Roque, where the major irregularities of the basin begin. The north-going Kelvin-wave is the most important with an amplitude of 52 cm and a high-water time of 1.8 hr at the south-west corner of the region considered. The south-going Poincaré-wave is the next most important, it has an amplitude of 35 cm and a high-water

time of 9.1 hr at the south-west corner. The other two free waves have each an amplitude of 22 cm at the south-east corner, and the high-water time of the south-going Kelvin-wave at this point is 10.8 hr, and that of the north-going Poincaré-wave 0.5 hr. The agreement with observation is good as far as 5° S latitude, but considerable divergences set in afterwards. Part of this divergence may be due to not including a sufficient number of Poincaré-waves, and Prof Proudman hopes to obtain better results by including more of these waves than he has done in the present investigations.

PLANT DISEASE AND THE WEATHER

CLIMATE exerts an important influence on the spread and severity of plant disease—an influence long recognized, though not yet fully investigated. Some recent progress in this field was discussed in a symposium arranged by the Department of Plant Pathology of the West of Scotland Agricultural College at Auchincruive on November 8. The meeting was attended by the advisory pathologists for Scotland, the staff of the Plant Pathology Service of the Department of Agriculture for Scotland, members of the College staff, of the University of Glasgow and the Hannah Dairy Research Institute.

Dr. C. E. Foister, head of the Plant Pathology Service of the Department of Agriculture for Scotland, opened by a short review of progress since the Conference of Empire Meteorologists in London in 1929. It becomes increasingly clear that records taken with ordinary meteorological exposure do not provide the pathologist with all the data he requires. It is necessary to study weather within the crop, and to follow up such information by investigations with artificially controlled conditions. Physiological races of fungi, moreover, may react differently to weather conditions. The distribution and occurrence of yellow rust of wheat in Scotland, for example, suggests the existence of different races varying in their reaction to environmental factors. Several parasitic fungi, common in England and Wales, are rare or unknown in Scotland, or confined to certain areas there. They include *Puccinia tritici*, *Septoria tritici*, *Rhynchosporium secalis*, *Phytophthora cactorum*, *Diaporthe umbrina*, *Heteropeltella anturhina* and the Dutch elm disease.

The rhododendron bug has twice invaded Scotland, but has failed to establish itself. How far are these apparent absences due to weather?

Dr. John Grainger, head of the Plant Pathology Department at Auchincruive, considered the aerial climate, the soil climate and the major effects of weather, with special reference to work carried out at Auchincruive in 1944. He showed how daily averages of aerial temperature and humidity inspired further work, but only continuous records within the crop revealed true phenological relationships. Chocolate spot of the field bean, bean leaf spot (*Ascochyta fabae*), and *Erysiphe graminis* on oats, all showed some increase of attack with rising relative humidity, but the real correlation was between disease intensity and the number of hours per day with complete saturation. Drain-gauge studies at Auchincruive have shown the large amount of rainfall evaporated from the soil. One aspect of aerial climate often neglected is that of conditions of

storage for seed, it might be possible to provide conditions under which the parasites lose the viability before the seed. The major effects of weather are mainly important in so far as they transport fungal spores from one area to another. It has been found, however, that large teleutospores of some rust fungi are not carried more than a few yards by wind. Climate cannot, of course, be controlled, but the practical value of weather studies lies in the following points: (1) its value in life history and mycological studies, (2) its help in raising immune or resistant crop varieties, (3) virus infected crops should be rogued within such temperature limits as the symptoms are not masked, (4) the time of farming operations can be adjusted to avoid some infections, (5) excessive atmospheric humidity may possibly be controlled in some parts of Scotland by adequate drainage; (6) conditions of seed storage may be devised to minimize seed-borne disease, (7) growers may be advised when to spray in order to eliminate disease epidemics.

The role of weather as direct pathogen in causing frost damage to fruit blossom was discussed by Dr. C. E. Cornford, of the Midland Agricultural College. Field experiments with orchard heaters were described which showed that the hot air they supplied was chilled or warmed by several other agents. These included katabatic winds, altitude, the amount of cloud, the presence or absence of large dense grass exposed to the sky, the humidity of the air and the dryness of the trees and soil.

Dr. B. T. Cromwell (Auchincruive) presided over the discussion which followed. Mr. A. Hedderley (Edinburgh) contrasted the epidemic of yellow rust in 1919 with its scarcity in 1944. The problem is complicated by the long growing-period of winter wheat. Dr. Mary Noble (Edinburgh) and Dr. Elizabeth Grant (Aberdeen) then contributed, and it appeared that winter wheat was generally much more susceptible than spring wheat in Scotland, and the severity of epidemics when they did occur was such that further detailed experiment was advisable. Dr. Grainger answered questions on frost damage in Dr. Cornford's absence. His own experience showed that oil heaters only raised the temperature of the air in their immediate neighbourhood by about 4° F. Evaporation from the buds lowered their internal temperature 2° F, giving a net internal rise of about 2° F. Tripping with humidified heating raised the air temperature near the source by 2° F, without internal cooling, thus resulting in a very considerable saving of fuel. Mr. Dovaston (Auchincruive) raised the question of avoiding grass cover in orchards subject to frost damage, but Dr. Cromwell and Mr. R. D. Reid (Auchincruive) held that grassing down was a very practical method of maintaining nutritional balance of the trees, particularly with regard to nitrogen.

Dr. Foister, Dr. Cromwell and Mr. Reid considered the occurrence of *Cladosporium* mould in tomato glasshouses. The disease was often more severe in low-lying houses on sandy soil than in higher situations on heavy soil, the factor of humidity did not seem to be the only one, and the admission of ultraviolet rays through 'Vita' glass did not eliminate the fungus. This discussion again pointed to the need for more detailed work. Dr. R. Laird (Ayrshire) mentioned that *Ascochyta fabae* and chocolate spot were more severe in low-lying, sheltered fields, but remembered that certain periods when these diseases were spreading were characterized by hot, dry days. Dr. Grainger explained, however, that long periods of complete

uration occurred during the nights at that time—act which again stressed the value of continuous records within the crop. Dr C L Whittles (Auchinave) urged the necessity for continuous records of the soil factors, as pH, water content, conductivity and oxidation-reduction potential.

INDUSTRIAL DEVELOPMENT IN AUSTRALIA

THE paper "Scientific Aspects of Australia's Industrial Development", which Mr G B Gresford read before the Royal Society of Arts on January 16, naturally covers a good deal of ground common with the annual reports of the Commonwealth's Council for Scientific and Industrial Research, though the account is rather more up to date, and in a larger setting. Mr Gresford referred particularly to the recent plans of the Australian wool industry, stimulated no doubt by competition from artificial fibres, for a large expansion of scientific research. Part of the large sum which the Australian Wool Board proposes to raise by increasing the levy on growers of wool would be spent by the Council for Scientific and Industrial Research on biological and textile research, and part would go towards economic research and publicity. Whether or not the opinion is justified that fundamental research will lead to the improvement of wool yield and quality, the cheapening of processing and the development of new and better fabrics so that wool can more than hold its own, the link between science and the wool industry becomes closer.

After a reference to research in connexion with new crops such as wheat, and the significance of the developments in the field of nutrition and developments in the manufacture of fertilizers and sulphuric acid, Mr Gresford mentioned particularly the part science has played in the development of the mining and metal industries. Investigations on flotation, and particularly the discovery of the collecting properties of sodium ethyl xanthate for the sulphide minerals, have led to the present high recoveries of lead and zinc in the flotation sections of the mines. The work at the University of Melbourne on fundamental physical chemistry of the flotation process, which ten years before the War was financed by a group of Australian mining companies, is now partly carried on by the Council for Scientific and Industrial Research. Work in new fields has suggested possible extensions of the flotation process to the concentration of new minerals. Mr Gresford also referred to the continuous lead refining process for dressed steel bullion evolved by the staff of the Broken Hill Associated Smelters as a striking example of the application of physical chemistry to an industrial process.

The paper industry, and particularly the development of processes for a wide range of papers from eucalyptus woods by a chemical or mechanical method, provides a further example of the solution by scientific research of a problem deemed intractable.

which has now made the Australian industry almost entirely independent of imported materials. Turning to the universities as sources of supply of scientific personnel for industry, Mr Gresford said that the demand at present greatly exceeds the supply, and if maintained it will involve a corresponding expansion of the universities. Plans have

been made for a considerable expansion of Government research activities, but further expansion of research in industry is desirable. So far, scientific exploration has not revealed any sources of flow oil in Australia, attention has not been given to the synthetic production of liquid fuels from coal, although the brown coal deposits of Victoria are very similar to those used in Germany for this purpose. Organic chemical industry on a large scale has scarcely been started and the development of the chemurgic industries, utilization of agricultural wastes, alkaloids and essential oils are other fields awaiting the application of scientific methods in Australia.

SYNTHESIS OF BIOTIN

A SYNTHESIS of biotin by S. A. Harris, D. E. Wolf, R. Mazingo, R. C. Anderson, G. E. Arth, N. R. Easton, D. Heyl, A. N. Wilson and K. Folkers, of the Research Laboratory of Merck and Co., Inc., has recently been described (*J. Amer. Chem. Soc.*, **66**, 1756, 1944).

The process involves several steps. L-cystine is reduced in liquid ammonia with sodium and coupled with chloroacetic acid to give β -(carboxymethylmercapto)-alanine, subsequent benzoylation and esterification of which yielded the dimethyl ester of N-benzoyl- β -(carboxymethylmercapto)-alanine. The diethyl ester was obtained by condensing thioglycolic ester with the ethyl ester of N-benzoyl- β -chloro-alanine, derived from N-benzoylserine by esterification and chlorination with thionyl chloride. The dimethyl ester was treated with sodium methoxide in methanol to give the sodium salt of 4-benzamido-3-ketotetrahydro-2-thiophenecarboxylic acid methyl ester, racemization occurring during the reaction. The sodium salt was hydrolysed and decarboxylated in an aqueous acetic acid-hydrochloric acid solution to give 4-benzamido-3-ketotetrahydrothiophene. The valeric acid side-chain was introduced by means of an aldehyde prepared from glutaric acid. The acid was converted in turn to glutaric anhydride, glutaric acid monomethyl ester, γ -carboxymethoxybutyryl chloride, and finally to methyl γ -formylbutyrate by a Rosenmund reduction.

The aldehyde ester, condensed with the ketone, 4-benzamido-3-ketotetrahydrothiophene, with piperidine acetate as catalyst, yielded the methyl ester of 4-benzamido-3-keto- $\Delta^{2,5}$ -tetrahydro-2-thiophenevaleric acid, which reacted with hydroxylamine hydrochloride in pyridine to yield the methyl ester of 4-benzamido-3-oximino- $\Delta^{2,5}$ -tetrahydro-2-thiophenevaleric acid, reduction of which by zinc dust in an acetic acid-acetic anhydride mixture gave two compounds, one the methyl ester of 3-acetamido-4-benzamido-4,5-dihydro-2-thiophenevaleric acid. Hydrogenation of this over a palladium catalyst and fractional crystallization of the products gave two racemates of the methyl ester of 3-acetamido-4-benzamidotetrahydro-2-thiophenevaleric acid. Each of these was hydrolysed with barium hydroxide, and subsequent treatment of the products with sulphuric acid gave the corresponding sulphates of the 3,4-diammotetrahydro-2-thiophenevaleric acids.

The acids, when treated with phosgene, yielded two racemates of hexahydro-2-oxo-1-thieno[3,4]imidazole-4-valeric acid, which will be called *dl*-biotin, and *dl*-allobiotin. The *dl*-biotin was resolved through its esters with L-mandelic acid to give biotin.

FORTHCOMING EVENTS

(Meeting marked with an asterisk * is open to the public)

Saturday, March 10

INSTITUTE OF PHYSICS (SOUTH WALES BRANCH) (in the Physics Department, University College, Swansea), at 2.30 p.m.—Inaugural Meeting Dr C Sykes "Physics in Metallurgy" *

Monday, March 12

FARMERS' CLUB (at the Royal Empire Society, Craven Street, Strand, London, W C 2), at 2.30 p.m.—Mr Geoffrey Crowther "An Economist Looks at British Agriculture"

ROYAL INSTITUTE OF CHEMISTRY (in the London School of Hygiene and Tropical Medicine, Keppel Street, Gower Street, London, W C 1), at 4 p.m.—Annual General Meeting

SOCIETY OF CHEMICAL INDUSTRY (YORKSHIRE BRANCH) (in the Metropole Hotel, King Street, Leeds), at 6.15 p.m.—Mr S. W. Butterworth "Flour", Mr E. F. Eaton "Colours in Foods"

ROYAL INSTITUTE OF CHEMISTRY (joint meeting with the INSTITUTION OF RUBBER INDUSTRY) (in the James Watt Institute, Birmingham), at 7 p.m.—Dr W. J. S. Naughton "Rubber Chemicals—Past and Present Influence on Synthetic Rubber"

ROYAL GEOGRAPHICAL SOCIETY (at Kensington Gore, South Kensington, London, S W 7), at 8 p.m.—Mr Christopher Sandeman "North-eastern Highway of Peru"

Tuesday, March 13

ROYAL INSTITUTION (at 21 Albemarle Street, London, W 1), at 5.15 p.m.—Sir Henry Dale, O.M., Pres. R.S. "Nerve Endings and Chemical Transmitters", (2) "Adrenaline and Acetylcholine", Adrenergic and Cholinergic Nerves"

INSTITUTION OF ELECTRICAL ENGINEERS (RADIO SECTION) (at Savoy Place, Victoria Embankment, London, W C 2), at 5.30 p.m.—Discussion on "Colour Television" (to be opened by Mr L. C. Jesky)

ROYAL PHOTOGRAPHIC SOCIETY (SCIENTIFIC AND TECHNICAL GROUP) (at 16 Prince's Gate, South Kensington, London, S W 7)—Dr H. Baines Presidential Address

Wednesday, March 14

ROYAL SOCIETY OF ARTS (at John Adam Street, Adelphi, London, W C 2), at 1.45 p.m.—Mr J. H. O. Bunge "The Thames Barrage and its Importance in the London Reconstruction Plans"

SOCIETY OF CHEMICAL INDUSTRY (FOOD GROUP, MICROBIOLOGICAL PANEL) (at the Chemical Society, Burlington House, Piccadilly, London, W 1), at 2.30 p.m.—Miss E. M. L. Elliot "Bacteriological Aspects of the Laboratory Examination of Meat", Mr L. B. A. Grace "Aspects of Practical Meat Inspection"

GEOLOGICAL SOCIETY OF LONDON (at Burlington House, Piccadilly, London, W 1), at 3 p.m.—Anniversary Meeting

ROYAL METEOROLOGICAL SOCIETY (in the small Physics Lecture Theatre, Royal College of Science, Imperial Institute Road, London, S W 7), at 4.30 p.m.—Major H. C. Gunton "Report on the Phenological Observations in the British Isles from December 1943 to November 1944"

INSTITUTE OF PETROLEUM (in the Lecture Theatre of the Royal Society of Tropical Medicine, 26 Portland Place, London, W 1), at 4.30 p.m.—Thirty-second Annual General Meeting

INSTITUTION OF ELECTRICAL ENGINEERS (TRANSMISSION SECTION) (at Savoy Place, Victoria Embankment, London, W C 2), at 5.30 p.m.—Mr W. Kidd and Mr E. M. S. McWhirter "Operational Control of Electricity Supply Systems"

SOCIETY OF CHEMICAL INDUSTRY (SOUTH WALES SECTION) (joint meeting with the ROYAL INSTITUTE OF CHEMISTRY) (at the Technical College, Newport, Mon.), at 6.45 p.m.—Dr H. E. Crossley "The Nature and Significance of the Inorganic Substances in Coal"

Thursday, March 15

CHEMICAL SOCIETY (at Burlington House, Piccadilly, London, W 1), at 2.30 p.m.—Prof E. K. Rideal, F.R.S. "Reactions in Monolayers" (Liversidge Lecture)

ROYAL INSTITUTION (at 21 Albemarle Street, London, W 1), at 5.15 p.m.—Sir Lawrence Bragg, F.R.S. "Some Physical Problems of the Solid State"

BRITISH INSTITUTE OF RADIOLOGY (in the Reid-Knox Hall, 32 Welbeck Street, London, W 1), at 8 p.m.—Mr L. Dudley "The Development of Stereoscopic Photography and Radiography"

Friday, March 16

ROYAL INSTITUTION (at 21 Albemarle Street, London, W 1), at 5 p.m.—Mr J. Z. Young "The Structure, Degeneration and Repair of Nerve Fibres"

BRITISH INSTITUTE OF RADIOLOGY (in the Reid-Knox Hall, 32 Welbeck Street, London, W 1), at 5 p.m.—Special General Meeting

INSTITUTION OF ELECTRICAL ENGINEERS (MEASUREMENTS SECTION) (at Savoy Place, Victoria Embankment, London, W C 2), at 5.30 p.m.—Dr G. F. Tagg "The Temperature Compensation of Indicating and Recording Instruments"

INSTITUTION OF MECHANICAL ENGINEERS (at Storey's Gate, St James's Park, London, S W 1), at 5.30 p.m.—"Invention after the War" (to be introduced by Mr Harold Sinclair, Mr E. W. Moss and Mr H. W. Cadman)

Saturday, March 17

BIOCHEMICAL SOCIETY (at the Middlesex Hospital Medical School, London, W 1), at 2 p.m.—Annual General Meeting

INSTITUTION OF MECHANICAL ENGINEERS (GRADUATES' SECT) (at Storey's Gate, St James's Park, London, S W 1), at 3.30 p.m.—Mr A. H. Lloyd "British Machine Tools during the War" (An Lecture)

ROYAL PHOTOGRAPHIC SOCIETY (SCIENTIFIC AND TECHNICAL GR) (at 16 Prince's Gate, South Kensington, London, S W 7)—Mr I. Chilton First Renwick Memorial Lecture

APPOINTMENTS VACANT

APPLICATIONS are invited for the following appointments on before the dates mentioned

LECTURER IN ELECTRICAL ENGINEERING for National Diploma Higher National Certificate Courses in the Crumlin Mining and Technical College—The Director of Education, County Hall, New Mon (March 16)

LECTURER (full-time) IN ENGINEERING SUBJECTS—The A. Principal Technical Institute, Clowne, Chesterfield (March 17)

ASSISTANT BIOCHEMIST—The House Governor, General Hospital, Birmingham, 4 (March 17)

ASSISTANT CIVIL ENGINEER (permanent) by West Ham Co Borough to take charge of the Civil Engineering Section of the Borough Engineers Department—The Ministry of Labour and National Service, Appointments Department, Central (T and S) Register, Room Sardina Street, Kingsway, London, W C 2 (quoting Reference E 1426 XA) (March 20)

METALLURGIST of Degree standard by large Engineering concern in S.E. England—The Ministry of Labour and National Service, Appointments Department, Central (T and S) Register, Room Sardina Street, Kingsway, London W C 2 (quoting Reference F 3537 XA) (March 21)

LECTURER (non-resident) IN GEOGRAPHY, with some MATHEMATICS—The Principal, Diocesan Training College, Salisbury (March 2)

LECTURER (full-time) IN THE DEPARTMENT OF ELECTRICAL ENGINEERING, and a SCIENCE LECTURER (full-time) IN THE DEPARTMENT OF BUILDING, of the Liverpool Technical College—The Director of Education, 14 Sir Thomas Street, Liverpool, 1 (March 24)

TECHNICAL INSPECTOR AND GRADER IN THE MILK PRODUCT DIVISION of the Ministry of Food at Colwyn Bay—The Ministry of Labour and National Service, Appointments Department, Central (T and S) Register, Room 5/17, Sardina Street, Kingsway, London, W C 2 (quoting Reference No F 3397 A) (March 26)

LECTURER IN SPINNING—The Registrar, College of Technology, Manchester, 1 (March 28)

ASSISTANT BACTERIOLOGIST (temporary), and LABORATORY ASSISTANT IN BACTERIOLOGICAL SECTION OF LABORATORIES (temporary) The Clerk to the Board, Metropolitan Water Board, New River House, Rosebery Avenue, London, E C 1 (endorsed "Assistant Bacteriologist" or "Laboratory Assistant", as the case may be) (March 31)

PRINCIPAL OF THE COUNTY MINING AND TECHNICAL SCHOOL, Nuneaton—The Organizer of Further Education, Council of Nuneaton (March 31)

PRINCIPAL OF THE LEIGH MUNICIPAL COLLEGE—The Secretary of the Local Higher Education Committee, Education Department Town Hall, Leigh, Lancs. (March 31)

SENIOR ASSISTANT IN THE COLLEGE LIBRARY—The Registrar, K College, Newcastle-upon-Tyne (March 31)

LECTURER IN GENETICS—The Secretary of University Court, University, Glasgow (April 7)

READER IN BOTANY AND HEAD OF THE BOTANY DEPARTMENT tenable in the Durham Division of the University—The Registrar, The University, 40 North Bailey, Durham (April 14)

PROFESSOR OF ECONOMICS—The Registrar, University College, Singleton Park, Swansea (April 21)

REGISTRAR—The Bursar (acting Registrar), The University, Lee (April 30)

SEDLIAN PROFESSORSHIP OF NATURAL PHILOSOPHY—The Registrar, The University, Oxford (June 2)

ASSISTANT IN THE DEPARTMENT OF AGRICULTURAL ECONOMICS under the Ministry of Agriculture Advisory Scheme—The Secretary and Bursar, Seale Hayne Agricultural College, Newton Abbot, Devon (March 31)

METALLURGIST (2) to undertake research in the welding of alloys—The Secretary, British Welding Research Association, 2 Epsingham Palace Gardens, London, S W 1

LECTURER IN SCIENCE (mainly BIOLOGY)—The Principal, Training College, Hereford

LECTURER (woman) to develop courses in GARDENING and RECREATION, and a LECTURER (part-time) with suitable qualifications experience to undertake with the students VOICE PRODUCTION, SPEECH TRAINING and SPEECH THERAPY—The Principal, St Mary's College, Cheltenham

TEACHER (full-time) OF MATHEMATICS—The Principal, Epsom Technical College, Queensway, Enfield, Middx

REPORTS and other PUBLICATIONS

(not included in the monthly Books Supplement)

London School of Hygiene and Tropical Medicine, incorporated in the Royal Institute Report on the Work of the School for the 1943-44 Pp 44 (London London School of Hygiene and Tropical Medicine, 1945)

Co-operative Electrical Research Pp 62 (London British Electrical and Allied Industries Research Association, 1944)

Tory Reform Committee Bulletin No 9 Approved Society Pp 4 (London Tory Reform Committee, 1945)

Catalogues

Technical and Scientific Books Pp 32 (Brooklyn, N.Y. Cherr Publishing Co., Inc., 1945)

Recent Purchases of Rare Books (Catalogue No 70) Pp (Caerleon Ifan Kyrie Fletcher, 1945)

NATURE

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FORESTRY AND AGRICULTURE

IN previous issues of *Nature* (Sept. 25, 1943, p. 337, and Dec 2, 1944, p. 693), we have reviewed the proposals made by H.M. Forestry Commissioners and the Royal Forestry Societies of Scotland and England for the future administration and control of forestry in Great Britain. Matters were taken an important stage further on February 15, when Sir John Anderson made a statement in the House of Commons that for "securing more complete and more direct Ministerial and Parliamentary control, the better co-ordination of the development of agriculture and forestry, and the most efficient use of the woodlands which survive the War, and of further land available for afforestation", it was best to "enlarge the sphere of the Ministry of Agriculture and Fisheries and the Secretary of State for Scotland, so that these Ministers may become jointly responsible for forestry policy and for supervising the measures for its execution" This decision—reached, it is reported, after prolonged consideration of various possible alternatives—should occasion no great surprise, and should be admitted to come as near as it is possible to come to reconciling the divergent views expressed on the subject. Details are not yet available, but it was definitely stated that under this arrangement, "the Forestry Commission will be retained as a single continuing expert body responsible directly to Ministers for advice on forest policy and for carrying out operations including training, research and forest holding"

There has been general agreement among those interested that the existing position was no longer satisfactory, however well it may have been suited to the conditions prevailing when the Commission was set up in 1919. Critics have reiterated their view that there should be direct Ministerial and Parliamentary control in place of the peculiar position, only paralleled to some extent by such bodies as the Ecclesiastical Commission, of being included in no department of Government and controlled only in financial matters by the Treasury They have also expressed dissatisfaction with the composition of the Commission and the method of appointment to it It is always easier to point out what is believed to be wrong with an organization than to provide a certain remedy, and though the various proposals run on fairly similar lines, it cannot be said that there is unanimity as to what would at this stage constitute the best composition of a revised Forestry Commission and how appointments should be made to it It will be noted that there is fairly general agreement, however, that in one form or another, a commission does provide the best machinery for carrying out the forestry work required to be done in Great Britain during the post-war period.

Taking first this question of Ministerial control, it will be remembered that the Commission's own proposal (Cmd. 6447, par. 55) was that if, despite its recommendations, Parliament should wish it to be placed under the control of a Minister, that Minister should be the Lord President of the Council, perhaps

working through a committee for forestry including the Secretary of State for Scotland, the Minister of Agriculture and the chairman of the Commission. The Royal Scottish and Royal English Forestry Societies made the same recommendation, but they set out their reasons at some length (Report on Post-war Forestry, 1944, p. 23). To the layman, it would seem obvious that if it is advisable to include forestry in an existing Ministry, it should go with the closely related field of agriculture, and he would probably find it difficult to imagine why both the Commission and its critics should wish forestry to be included among the bodies under the control of the Lord President, which include the three important research bodies, the Medical Research Council, Agricultural Research Council and Department of Scientific and Industrial Research. What is it, then, that prompts the forester to look for some alternative to such linkage at the Ministerial level with agriculture? The answer lies primarily in his belief that there is a real risk that a Ministry of Agriculture might not accord to forestry that share of interest, staff and total available resources to which forestry considers itself entitled, that, in the terms of a much repeated quotation, agriculture might in fact treat forestry as its handmaid, taking moreover an out-of-date view of the proper relations between mistress and handmaid. If then the further question is put—What grounds has the forester for this mistrust?—reference might be made to the history of the relationship between the two forms of land use in certain parts of the British Empire, where forestry, when it was in competition with agriculture, appears to have had a difficult struggle to obtain a full hearing of its case and adequate recognition. Some of these points do indeed appear to support the argument, but clearly much depends on the setting, and it is easy—again ignoring the setting—to find illustrations working in the opposite sense, for example, the ultimately successful demand of the United States Forest Service early in its history to be included in the Department of Agriculture, and the strong opposition more recently to any proposal to break up this administrative arrangement. "The situation seems to call for careful consideration and, if necessary, the provision of some such safeguard as expressly earmarking funds for forestry. In view of the known interest in forestry of the Ministers who are at present responsible for agriculture in Britain, foresters need have few fears, but both appointments are political and the incumbents subject to change."

There was, moreover, thought to be a constitutional consequence of placing forestry in the same hands as agriculture, which British foresters generally deemed highly undesirable, namely, a splitting up of the existing single organization for Great Britain as a whole into two parts, one for Scotland under the Secretary of State for Scotland, and the other for England and Wales under the Minister of Agriculture and Fisheries. H.M. Commissioners are emphatic on the point (Cmd. 6447, par. 533), and so are the two Forestry Societies, though they consider the difficulty could be got over (cf. their Report, p. 23). Unity is

considered necessary to "ensure the high standard and *esprit de corps* expected of the Forest Service, adequate services for research, education and information, and a strong front to carry out an agreed national policy." It will be noted that this need arises from the fact that in Britain, even after the considerable expansion contemplated, forestry will still remain as a relatively small item on the national programme. Subdivision would mean further loss of strength, and the two services would each, in several aspects of their work, be too small for efficiency with economy. Obviously there must be a large measure of decentralization, permitting matters which are purely Scottish concern being dealt with in Scotland but no significant change from the present position will be required to ensure this. There will be dissatisfaction in Wales if special provision is not included to ensure the fullest consideration of Welsh interests, particularly as Wales will certainly be called on to provide a large proportion of the land required for afforestation. The existing consultative committees have been found to be too exclusively consultative, too lacking in power to press the views, to be acceptable.

It will be noted with approval that the Government has taken into account the need of the better coordination of agriculture and forestry. This is in keeping with the times, for this need is becoming more and more apparent to thinking men in both professions as well as to those responsible for general administration. The Forestry Commission has often been charged with disregarding it when acquiring land for State afforestation. It is of even greater importance in the case of privately owned woodlands, which must almost always be handled as an integral part of a mixed estate—woodland, arable and pasture, having their appropriate balanced parts to play in the general rural economy.

The statement made in the House of Commons also indicates that although we shall continue to have a Forestry Commission appointed by the Crown, its composition will be fundamentally altered by dropping the practice which has grown up of appointing representatives of each of the three chief political parties—one of the Commissioners had to be a member of the House of Commons to act as spokesman.

Men of science will note the specific mention of research as remaining under the control of the Forestry Commission, and perhaps wonder why it is not proposed to bring it under the Agricultural Research Council, as this would seem to be a logical step if the Ministry of Agriculture is to become responsible for forestry. A further announcement will be looked for with interest, as there have been numerous charges of inadequate attention to research in the past, but it may be noted that it would be quite possible for the necessary work to be shared between the Agricultural Research Council and the Ministry. The Ministry of Agriculture already has its own research stations for special problems, particularly those of a highly technological nature, and there are strong reasons why the Forestry Commission should in any event continue research of this type on

a wider scale than hitherto. Research of a more fundamental nature, which it has been the practice to 'farm out' to universities and other institutions wherever the best facilities were considered to exist for handling the individual problems, could perhaps more appropriately be taken over by the Agricultural Research Council, suitably enlarged by inclusion of persons with expert knowledge of the scientific aspects of forestry. There is a vast field for research into primary forest soils, tree physiology, and forest ecology in the widest sense, that has hitherto been much neglected. A variety of reasons for this neglect has been adduced, including experimental difficulties, lack of realization of the need for research, and lack of appreciation of the practical importance of the work. The essential requirement now is to remedy this, whatever is decided to be the best administrative arrangement to that end.

The accomplishments of the Forestry Commission during the first twenty-five years of its existence are reviewed in an article by Prof. E. P. Stebbing appearing in this issue (p. 317). If not a few matters are found for criticism, the reasons are often to be traced to the conditions under which the work has had to be done. It is indisputable that a great deal of valuable work has been accomplished during this quarter of a century, the completion of which would in any event have been a very appropriate time to take stock of the position reached. The initial difficulties involved in launching forestry as a new State activity have been successfully met. The nation's requirements can now be re-assessed and plans laid for a further period on the long-term views essential to sound forestry. In particular, we should now leave behind us the over-emphasis that has been laid on the afforestation aspects, give more attention to tending and management, and to preparing for the utilization problems that will shortly be upon us as the large acreages of plantation come into production. But the most significant feature of development to be anticipated in the draft legislation we are promised shortly is the proposed extension of the State's direct interest in some two million acres of privately owned forest. The Commissioners will need much imagination, tact and skill if at the end of the second twenty-five years they are to record as much progress in this field as they can record for their afforestation work since 1919. We believe this to be possible, and we certainly wish them every success in their task.

THE ROYAL SOCIETY, 1660-1940

The Royal Society, 1660-1940

A History of its Administration under its Charters
By Sir Henry Lyons. Pp. x+354. (Cambridge: At the University Press, 1944.) 25s. net

AFTER Sir Henry Lyons had finished his work on the fourth edition of the "Record of the Royal Society", he wrote in June 1940 to the present reviewer: "I have learned that what is badly needed is a new 'History', for, as you know, Weld's ends at 1830. Greatly daring I started on this about 2½ years ago and have got my first rough draft of half

of it in shape already. Now that I have got most of my facts collected and checked I see my way more clearly.", and again, in November 1941, "The further I get with it the less satisfied I feel". The subject tempts one to fling a wide net, but I have tried to keep to the story of how the Councils and the Fellows carried out their trust as laid down in the Charters, and with what degree of success." Notwithstanding the dislocations and discomforts of war-time aggravated by growing illness, he steadfastly completed that task, and lived to see his text in print but not to see it published. In the book, he says that he regards it as the introduction to a second volume which must be left for another hand to write a century or two hence—a remark which well illustrates the sense of continuity that permeates his work, and indeed, every fellow of the Royal Society should, with like diffidence, be a 'student of perpetuity'.

After a note by Sir Henry Dale, president of the Royal Society, and the author's introduction, the seven chapters of the book flow in chronological order from the sixteen-forties to 1940 (with repetitions wherever the author has not let system stand in the way of narrative needs), so as to bring out well-marked successive changes in the Society's life. Appendixes give a full translation of the second Charter (1663) into English, and statistical data, and there is a full index of names and subjects.

Throughout the book the author repeatedly insists—and produces evidence for it—that a scientific society can be run only by scientific men. The Charter of 1663 had expressed the lofty vision and purpose of the scientific founders and their wise lay supporters, but their momentum waned with the century, and during the seventeen-hundreds and later, the growing proportion of non-scientific fellows exercised, as the author shows, "a restraining influence on the Society's activity and hindered its steady growth as a scientific institution, after 1820 the control of the Society passed into the hands of men of science with the result that it quickly became what its founders had originally intended it to be, an institution devoted wholly to the advancement of scientific knowledge".

As would be expected from Sir Henry Lyons—a fellow of the Society for thirty-eight years and its treasurer for ten—the evidence which he presents is never guesswork; he always goes to original sources; much is from documents not hitherto used for publication, and, wherever he can, he adds quantitative data. Thus, not only is the book full of interesting facts about persons, but also it discusses such matters as lengths of tenure of office, the number of meetings of Council held in different years, the attendances at them, the representation on them of different occupations, scientific and other, their administrative and legislative acts and controversies, and the finances of the Society as far back as records go.

The graph on p. 344 plots the number of fellows for each quinquennium from 1663 until 1940, and is interesting. A few years after the foundation there were some 215 fellows, about a quarter of them scientific, but by the sixteen-nineties there were only 115, the nadir in numbers. The ensuing rise went on for a hundred and fifty years, and in the early eighteen-forties the fellowship touched its numerical peak, 766. But now began to be felt the reformation of control and administration which the author calls "The Scientific Revolt, 1820-1860", and, new elections of laymen having ceased, the total

number thenceforth fell, and so steadied down to about four hundred and sixty fellows and about forty foreign members, near which it has stayed for the past half-century.

Any serious work of history which scrupulously sets forth the evidence for its own inferences is, to some types of reader, dull. These types will be little attracted by this book, but it is not for them that Lyons wrote it. A scientific man and a careful historian, he wrote for his fellows, and perhaps above all for those who have or might have some part in the conduct of the Royal Society. There is none of such persons who should leave this work unread, it will teach them much of practical value. One of the many lessons implicit in it is that lively administration is essential to the furtherance of science but yet must be kept subservient to it. The Society has long learnt this, but it is sometimes forgotten by other planners, in their enthusiasm for logic and systems, that the best men of science are each *sur generis*, not units for regimentation, but beings for whose individual activities *qua* scientists the organization of society must elastically provide.

There is also another kind of reader who would well profit from some study of this book—namely, the general historian. For in the long run of history, thought proves more potent than engines, and the phases of the Royal Society in the past three centuries have partly reflected, but partly originated, deep changes of general thought in the nation at large, and beyond, and, without doubt, the recognition and tracing of these correlations enlightens real history.

J. I. O. MASSON

THREE MEN OF SCIENCE

Famous American Men of Science

By J. G. Crowther. Vol. 2. Thomas Alva Edison; Josiah Willard Gibbs (Pelican Books, A 105) Pp. 160. (Harmondsworth and New York. Penguin Books, Ltd., 1944.) 9d.

S. Z. Ferranti

(Science in Britain Series. Published for the British Council.) By L. Randell. Pp. vi+30+4 plates. (London. Longmans, Green and Co., Ltd., 1943) 1s net.

IT would be difficult to select two men of science who by ancestry, upbringing, development and achievement differed more widely than Thomas Alva Edison (1847–1931) and Josiah Willard Gibbs (1839–1903), whose careers are described in Mr J. G. Crowther's book. Of Dutch descent, Edison's forbears were physically strong, long-lived and commercial, while Gibbs came of British stock, less robust and devoted to academical studies. Of intensely practical habit of mind, Edison was given to inventing as much as Gibbs was to abstract reasoning. When during the Civil War of 1861–65 Gibbs was studying and lecturing in the seclusion of Yale, Edison, a mere boy, was selling and publishing the first newspaper printed on a train and beginning his career in telegraphy. Gibbs inherited ample means for his needs, Edison had to make his own fortune. Edison owed nothing to teachers, Gibbs everything, and from the age of twenty-six to twenty-nine was able to study under famous physicists in Europe, but both made notable contributions to scientific and industrial progress.

To understand Gibbs's work, however, a thorough grounding in scientific principles is necessary, but everyone can appreciate Edison's hundreds of inventions, his lamps, dynamos, phonographs, etc. It is impossible to compare the two men, they were as different in temperament, character and mode of living as Cavendish and Trevithick. Mr Crowther rates Edison as "the greatest inventor recorded in history", but that and other statements only provoke one to thought, just like the story of the members of a British scientific society who, balloting for the greatest twenty scientific men since the Renaissance, chose in order, Newton, Darwin, Faraday, Einstein and Gibbs. One of Gibbs's contemporaries who worked at thermodynamics was John Macfarlane Gray (1832–1908), but Gray was not, as Mr Crowther says, "chief engineer of the British Royal Navy", his official position was examiner of engineers for the Board of Trade.

In the same category of men of genius can be placed Sebastian Ziani de Ferranti, who is the subject of Mr L. Randell's little pamphlet, one of a series dealing with British men of science and scientific institutions being published in English, Spanish and Portuguese for the British Council. Ferranti was born in Liverpool in 1864, and by the age of twenty was a manufacturer of dynamos, meters, transformers, etc. His early years were as astonishing as those of Edison, and to him more than to any other single individual is due the conception of the central super-power station generating electricity at high voltage, and its distribution over wide areas. He died in 1930, honoured throughout the engineering profession.

U.S. ANIMAL INDUSTRY

Introductory Animal Husbandry

By Prof. Arthur L. Anderson. Pp. xi+777. (New York. The Macmillan Company, 1943.) 20s net.

BETWEEN Britain and the United States there are many differences in situation, and there is a corresponding diversity of outlook. Such differences are particularly marked in their respective livestock industries and are historical and geographical in origin. Many of the American breeds came from the British Isles, but, in the place of stock in agriculture, in marketing arrangements, in food habits, there are great contrasts. The Englishman likes his breakfast bacon and Sunday joint, the American prefers porter-house steak, frankfurters, and (in moderation) 'Spam'. Britain is not self-sufficient in meat or animal feeding stuffs, livestock are an essential part of an intensive mixed agriculture, droughts are very inconsiderable affairs. In America there are well-defined regions—cotton, wheat and corn belts, distances are important because dairying must be within a few hours' journey of population centres, the opening up of the interior by railways led to the packing-house system.

Prof. Anderson, in the scope of his book, has been guided by a survey by his publishers. It is designed as a text-book for students beginning a college course and for reference in vocational training. Sections of approximately equal length deal with beef cattle, milking cattle, sheep, pigs, and horses and mules. References are given only to readily accessible American publications.

Animal husbandry is defined as the breeding, feed-

ing and management of domestic animals, in introducing the subject, the author is less concerned with the animals than with their position in domestic trade and the economics of their production. Thus, of ten chapters dealing with beef cattle, one is devoted to feeding and management and one to breeding; the remainder concern show-points and classes, marketing, meat grading, by-products and consumption, together with a brief historical introduction. Extensive use is made of statistics from packing-houses, U.S. Department of Agriculture surveys and the like, dealing with such matters as seasonal fluctuations in market receipts and prices, percentage losses through injury in shipment by rail or road, average live-weights at slaughter-houses, milk distribution costs, and so on. A list of slaughter-house by-products and their disposition extends to incense and oriental medicine. In contrast, no details are given of the composition of feeding stuffs, nor is there any mention of the ruminant stomach (except as tripe). Similarly, though wastage in dairy cattle is very high, there is no discussion of the causes. A curious omission is the absence of any reference to machine milking.

Housing, feeding and breeding are dealt with very briefly, a survey is given of usual practices and of economic aspects such as the price equivalents of corn and butterfat. Certain remarks on management have a very practical ring and a more than local application. Two may be quoted here: "To top the market with beef steers is the fond hope of many cattle producers. It is not always related to the most profit from the feeding enterprise", and again, of sheep: "Not all pure-bred flocks exhibit sheep at shows and expositions, but fitting for sale is essential for selling to the best advantage. Likewise a pure-bred flock manager should have salesmanship ability. The showing of a flock at the livestock shows is a form of advertising."

Prof. Anderson has aimed at the presentation of facts and the avoidance of matters of controversy. He has made much use of the findings of technical investigations. Some three hundred illustrations portray for the most part ideal breed types, industrial processes and price and population trends.

FUNDAMENTALS OF ASTRONOMY

From Atoms to Stars

By Dr. Martin Davidson. Pp. 188. (London, New York and Melbourne: Hutchinson's Scientific and Technical Publications, 1944.) 15s. net.

BOOKS written with the view of meeting the enlarged interest in astronomy manifested by the ordinary individual in recent years have not been lacking on either side of the Atlantic. One of the latest, for British readers, bears the comprehensive, if somewhat inconsequent, title "From Atoms to Stars" and is from the pen of Dr. Martin Davidson, prominent among British astronomers for his wide theoretical knowledge of the subject. To quote from the preface, it is "intended to provide a general outline of the most up-to-date knowledge of the heavenly bodies and also to show the methods employed by the astronomer to derive their distances, sizes, masses, temperatures, etc."

It is the latter aim which gives to the book its distinctive character. As if to warrant the title,

Chapter I is devoted to an account of the structure of the atom, according to present views, touching upon ionization, radioactivity, transmutation and allied phenomena. The reader is thus prepared for a description, later in the book, of the sub-atomic processes by which the enormous output of radiant energy continuously emitted by the sun and the stars has been maintained for thousands of millions of years.

The succeeding chapters follow the general plan adopted in books of this type. They deal in turn with the sun, the earth and the moon and phenomena relating to these bodies, next with the other members of the planetary system, including meteors and comets, and then five chapters are devoted to the stellar universe at large, in all its diversity of objects. Positional astronomy and star-configuration find no place in the book.

Each chapter contains, in addition to ample descriptive and explanatory matter, much interesting detail of a kind not commonly found in non-technical books, while in a few cases a short bibliography is appended for the information of readers who may wish to enter more deeply into the subject.

Dr. Davidson's mathematical bent finds an outlet in the fulfilment of his promise to show how astronomers tackle their theoretical problems. Many worked examples are incorporated in the text, most of them being in reality quite elementary, and some, perhaps, given at unnecessary length. This plan makes it difficult for readers to avoid the arithmetic even though they may wish merely to know the methods.

The final chapter contains a summary of various theories of the origin of the sun's planetary system, beginning with those of Kant and Laplace and concluding with several speculations of very recent date. The author is of opinion that none is really satisfactory.

A few typographical mistakes have slipped through the "proof" stage—chiefly transposition of digits, of which the outstanding example is on page 132, where the value of a radian in degrees is stated to be $\pi/180$ instead of $180/\pi$. On pages 152, 153 "J. C. Adams" is a slip for Walter S. Adams. The director of Mount Wilson Observatory, California, is of course not to be confused with the ever-famous Prof. J. C. Adams of Cambridge, who first demonstrated the existence of the planet Neptune, which was discovered later. It is surprising, also, to find Dr. Davidson giving renewed currency to the idea that the double high tides experienced at certain places—for example, at Southampton—are due to the successional arrival of the tidal wave by two different routes. This superficially plausible explanation has been shown by such authorities as Lord Kelvin and Sir George Darwin to be fallacious.

The book is illustrated with excellent photographs and many instructive diagrams. The style is pleasantly colloquial, though a feeling sometimes arises that the author, in compressing his material, is unconsciously stepping above the standard envisaged in his preface, and is taking for granted rather more astronomical knowledge than the average reader would be likely to possess. Nevertheless, to readers with ordinary scientific outlook, "From Atoms to Stars" can be heartily recommended as an authoritative, up-to-date outline of astronomy's wonderful achievements in the exploration of the infinities both of space and time.

W. M. WITCHELL.

The Chemical Testing of Plant Nutrient Solutions
By G. S. Fawcett and Dr R. H. Stoughton Pp. 86
(Salisbury The Tintometer, Ltd, 1944) 8s. 6d

THE routine testing of plant nutrient solutions is undoubtedly an important part of most investigations on the soilless growth of plants, and the genuine investigator must therefore be competent to carry out the necessary chemical operations. In this book, which is essentially a set of directions for carrying out the tests, the authors have succeeded in reducing the operations to as simple a form as possible, to give speed in analysis but yet to retain an accuracy sufficient for the purpose. This result has been achieved by employing, in all cases, colorimetric or nephelometric methods which must be used in conjunction with the 'All-Purpose Lovibond Comparator' and special standard colour and turbidity disks and comparator tubes. The chemical methods have been selected from text-books and the literature, and have been adjusted and critically tested under the conditions existing in plant nutrient solutions. They provide for the estimation of the major plant nutrients and the minor and trace elements manganese, iron, boron, copper and zinc. In some cases the methods are tentative and the authors hope to improve these. As with the simplification of many chemical methods, the applicability is restricted, in this case to plant nutrient solutions only, and the authors are emphatic that all details be adhered to closely. If this advice is followed, the novice can carry out some of the tests by himself, but others involve highly corrosive chemicals, and although ample detail and space is devoted in the early part of the book to the very elementary operations of handling chemical glassware and reagents, those who are inexperienced in chemical technique should, in the opinion of the reviewer, receive a short preliminary training.

This book, together with the specially designed apparatus, should prove a great help to experimenters in the soilless cultivation of plants. R. G. WARREN

Symposium sobre Raios Cósmicos, Rio de Janeiro, Agosto 4-8, 1941

Pp 180+19 plates (Rio de Janeiro Academia Brasileira de Ciências, 1943)

IN this volume are reprinted, in English and French, the papers given at a symposium on cosmic rays held in August 1941 at Rio de Janeiro, under the auspices of the Brazilian Academy of Sciences, on the occasion of the visit of a group of American physicists led by Prof. A. H. Compton. The scope of the conference is indicated by the following titles selected from some twenty papers: (1) "On the Fluctuations of Cosmic Rays", by A. H. Compton, a discussion of the sidereal time variation of cosmic rays; (2) "On the Latitude Effect of Cosmic Rays", by B. Gross; (3) "Cosmic Ray Studies in the Andes of Southern Peru", by N. Hilberry and A. H. Hilberry. This paper describes the determination of the variation in the frequency of extensive showers with altitude, up to 5,850 m above sea-level, for two different counter arrays, and affords an interesting proof that most extensive air showers are initiated by high-energy electrons; (4) "Cloud Chamber Photographs at High Altitudes", by D. Hughes; (5) "The Latitude Effect for the Hard Component of Cosmic Rays and Evidence as to the Nature of the Primary Radiation", by W. P. Jesse; (6) "The Influence of a Solar Eclipse on the Cosmic Ray Intensity", by Y.

Monteux, G. Occhialini and M. D. Souza Santos. (7) "On the Ultra-Soft Component of Cosmic Radiation", by G. Occhialini and M. Schonberg; (8) "Showers of Penetrating Particles under 30 m of Clay", by P. A. Pompeia, M. D. Souza Santos and G. Wataghin; (9) "On the Production of Mesotrons at High Altitudes", by E. O. Wollan. This interesting paper gives the results of balloon flights to determine the multiple production of mesons as a function of altitude. No maximum is found up to a height corresponding to a pressure of 3 cm of mercury.

It is unfortunate that publication of this report has been so long delayed, for much of the original work presented at the conference has been published in the meantime. G. D. R.

Fitz-James O'Brien

A Literary Bohemian of the Eighteen-Fifties By Prof. Francis Wolle (University of Colorado Studies, Series B Studies in the Humanities, Vol. 2, No. 2) Pp. xi+309. (Boulder, Colo. University of Colorado, 1944) 2 dollars

IN this painstaking and amply documented study Mr. Wolle follows the fortunes of a young Irishman who arrived in New York in 1852 with nothing but his wit and ready pen for luggage, and, in the next ten years, poured out a flood of ephemeral literature, reflecting the many facets of contemporary society. Such a chameleon could not escape the mid-nineteenth century interest in scientific discoveries and pseudo-scientific speculation. In his short stories, which rival in horror those of Poe, figure an invisible monster, a glass eye, robot killers, disembodied organs which continue to function normally, a swiftly revolving ball which is impervious to the force of gravity ("How I Overcame My Gravity"), a telepathist and, in his best-known work, "The Diamond Lens", a microscopist. This miscreant, by means of cold-blooded murder, produces the perfect lens, only to discover his ideal woman in a drop of water. Unable to make contact with her, he is doomed to watch her fade as the water evaporates. He goes mad.

Unfortunately science, in the hands of an inept surgeon, was unable to save O'Brien from the result of a pistol shot in the left shoulder, which he got while fighting with a New York regiment during the Civil War. After much needless suffering, a resection of the joint was decided on, tetanus set in, and this gifted but irresponsible Bohemian died at the age of thirty-three. Whether he would ever have fulfilled the fitful promise of his early years seems doubtful, and one wonders if it was worth while so meticulously to disinter his literary remains. They have something of a charnel-house smell, and one can only wonder at the mediocrity of a literary society in which their author ranked with the best. PHYLLIS HARTNOLL

Studies on Immunisation

Second Series With Appendices dealing with Anti-typhoid Inoculation, Chemotherapy, and Statistical and other Operations of Induction. By Sir Almroth E. Wright (Researches from the Inoculation Department, St. Mary's Hospital, London, W.2, Vol. 4) Pp. vii+256 (London: William Heinemann (Medical Books), Ltd., 1944) 25s. net

THIS volume contains selections from the published works of Sir Almroth E. Wright and his collaborators. The subjects include vaccine therapy, prophylactic inoculation against pneumonia, and other aspects of the field of immunity.

THE FORESTRY COMMISSION

THE FIRST TWENTY-FIVE YEARS

By PROF. E. P. STEBBING
University of Edinburgh

AS a result of the restrictions on imports and the heavy fellings made in the woods in Great Britain during the War of 1914-18, a Forestry Subcommittee was set up to consider the question for the country as a whole, and its report, the Acland Report, was accepted by the Minister of Reconstruction and the Cabinet as a basis upon which to frame a Forestry Bill. This Bill was passed in 1919.

The idea underlying the framing of the Bill was the necessity of making provision, against a possible future war, for a three years supply of timber and pit wood in the country. The estimated area to furnish this amount was laid down as 1,770,000 acres. This area was to be planted in a period of eighty years at a total cost of £15,000,000. During the first ten years, for which the Bill provided, an area of 250,000 acres was to be planted at an estimated cost of £2,872,500.

The chief work, therefore, of this new State Department was to bring into being a State ownership of forest land and to afforest all suitable parts of these areas, to create, in fact, national forests, a type of ownership of woods which had never previously existed in Britain. For the so-called State forests, the Dean, New Forest, and so forth, were originally, and had come down to us solely as, the personal property of the Crown. This pioneer work of acquiring land, draining, clearing, fencing and raising the plants required in nurseries and having the requisite number ready each year for the estimated areas to be planted up was by no means so easy as had perhaps been anticipated by some of the most ardent adherents of the new departure. Further, the recruitment of the indispensable trained staff proved another difficulty. Under the Forestry Bill the Commission was to receive annual grants to cover its expenditure. In forestry, a type of work necessitating the longest views, since trees do not grow to maturity in the brief space of agricultural crops, a departmental budget based on stability is indispensable. The financial crises which supervened between 1920 and 1931 had their automatic effects on checking and upsetting the annual planting plans so rigidly laid down in the Acland Report, one of its chief failings, and consequently the activities of the new department. In this connexion and owing to the inexperience of the staff, unnecessary waste was inexorably incurred at these set-backs. Large numbers of plants were actually burnt in the great nurseries owing to the cutting down of the yearly planting programme, whereas there is no doubt that they could, with considerable advantage, if only in the interests of the taxpayer, have been offered at the cost of carriage to private owners of woods, as is so commonly done in Europe and, in fact, is at the present time being done in certain parts of the British Empire overseas.

In this connexion there was another serious drawback to the Acland Report, to which the Commission adhered so rigidly. The report was based almost solely on the annual planting of conifers. The valuable British broad-leaved species or hardwoods were almost entirely neglected. In fact, in parts of

Britain where poorly managed areas of coppice with standards were purchased with the estate acquired by the Commission, such was the conifer obsession that these areas after being cleared were planted with conifers, this often resulted in a heavy cleaning expenditure for a number of years to prevent the resultant coppice shoots—the natural tree flora of the locality—from smothering and killing the expensively raised and planted conifers.

It will be readily admitted that the new department had to show results, or it would have risked suppression at the hands of a lukewarm Government, House of Commons and public, and conifers are easier to raise and plant and grow more quickly than hardwoods. Moreover, the bulk of the land acquired by the Forestry Commission was conifer land.

The acquisition of the necessary land did not prove so easy. For one thing, the agricultural parts of an estate together with buildings and so forth had to be acquired, since a depreciation in values would result if only a specified portion of an estate were sold.

In the past twenty-five years the Commission has acquired approximately $1\frac{1}{2}$ million acres, of which half a million acres has been afforested and a quarter of a million acres remains to be planted. The rest of the land is either unproductive, above the present possible plantable elevation, and mountain tops, or land which is agricultural in its broadest sense and therefore does not fall within the province of the forester. These land areas now belonging to the State, that is, the public, are spread over 263 forests, of which 102 are in England, 39 in Wales and 122 in Scotland. It was foreseen that in these at present out-of-the-way-regions it would be necessary to make provision for accommodation for permanent forest workers. A programme was therefore prepared for the building of forest holdings, that is, houses each with an acre or two of land to produce vegetables and so forth, 1,500 of these holdings have been established during the period.

In England and Wales an area of 625,505 acres of land has been acquired, of which 464,178 acres is plantable land, the rest being described as agricultural holdings, nurseries, unplatable, etc. The areas planted were 276,898 acres of unafforested land and 49,102 acres of acquired woodland (the New Forest, Forest of Dean, etc., made over to the management of the Commission). The chief species used in the re-afforestation work and in planting in the acquired woodlands were Scots and Corsican pine, European and Japanese larch, Norway and Sitka spruce, Douglas fir (very popular in the early years of the Commission), oak and beech. In Scotland the total area acquired has amounted to 627,000 acres, of which 316,000 acres is plantable. The area planted has amounted to 163,000 acres, the species used being Norway and Sitka spruce, about 53 per cent, Scots and Corsican pines, about 26 per cent; European and Japanese larches, about 11 per cent, others, 10 per cent.

On the subject of private forestry, the Commission states that grants given for planting in private woodlands have been made in respect of 145,000 acres, the grant being £2-£4 per acre. Land owners, while gladly acknowledging this assistance, complained that since practical assistance by the Commission was not available, the planting-rate on estate woodlands was not much more than 6,000 acres a year, as compared with nearly double in the early years of the present century, although after

the heavy war fellings during 1914-18 the planting-rate should have been greatly accelerated. In 1914 some 97 per cent of the woods in Great Britain, amounting to $2\frac{1}{2}$ million acres, were privately owned. The Commissioners claim, nevertheless, that advice on many aspects of forestry has been given to private owners. But it must be admitted that the private owners had a strong case when they maintained, first, that the new and very young State forest staff had a full-time job, increasing with the passing years, and that little time was therefore available for advice to the private owner. More than this was, however, involved, the training and experience of the staff, with no long tradition and no precedents behind them, were not always adequate to enable them to advise in the management of estate woodlands, especially the smaller ones, which presented a whole set of quite different and often very complex problems.

An interesting side-line of the work of the Commission, but a natural development, as it turns out, is the creation of three national parks on the State-owned forest land, and two more are to follow. The controversies which have taken place over the question of the afforestation of beauty spots were probably almost inevitable in a country such as Britain, with a population which knew nothing about forestry or its objectives and had lost all forest sense. That the young department may have blundered in some cases is scarcely to be wondered at. But the ignorance of the public on the subject was equally apparent.

Towards the end of the period here dealt with, the Commissioners have prepared two White Papers on post-war forestry. The first of these has had a first reading in the House of Commons.

The present Commissioners were appointed by the King, and their average length of service is now ten years. The first chairman and the man who may be said to have made the Commission was the late Lord Lovat, 1919-27, followed by Lord Clinton, 1927-29, Sir John Stirling Maxwell, 1929-32, and then Sir Roy L. Robinson, 1932 to date. Mr Robinson was the technical commissioner to Lord Lovat and remained in the Commission in this capacity until his appointment as chairman. In the first few years, the Commission consisted chiefly of landed proprietors—to this reason perhaps may be attributed the failure to start replanting all the cut-over areas of 1914-18, since they might have been accused of helping themselves. On the other hand, it is conceded that it was due to Lord Lovat as chairman that the Commission survived the financial crises which supervened so quickly after its birth. Latterly, the Commission has had a far greater political and House of Commons flavour in its composition.

A point often raised during the past twenty-five years was the irresponsibility of Ministers and the Cabinet for the progress of forestry in Great Britain. The Forestry Commission was represented by a Commissioner, a member of the House of Commons, who acted as its spokesman. Many considered that this was far from effective, that it placed the afforestation programme of the country, a purely public matter, in constant jeopardy, that, in fact, either the business was sufficiently important to deserve the attention of, and responsibility for, a Minister of State, or the Government should give its reason for leaving the matter in the hands of a more or less autocratic authority control led solely by the Treasury. This may be said to have been the

practice at the close of the twenty-five years work. In the House of Commons on February 15 it was announced that the Minister for Agriculture and the Secretary of State for Scotland will in future be jointly responsible for forestry, the Forestry Commission being retained as an advisory body with executive functions (see p. 311).

One of the present troubles the staff of the Forestry Commission have had to deal with has been fire damage, always a serious danger with large areas of young conifers. Considerable research work into certain problems in connexion with little-known aspects of the work facing them was undertaken in the early years, for example, investigations into seed qualities and the best regions to obtain the seed from, since so many of the species being used in the new work were exotics, nursery investigations on methods of sowing, soils, rate of growth and so forth, manuring, diseases in the nursery, both fungal and insect attacks, etc., including climatic factors, brought forth excellent results in some cases, as also the studies made of the soil flora in different regions and growth statistics. More spectacular and easier to understand were the experiments carried out with the object of learning how to plant areas of peat land often of some depth, of which a not inconsiderable proportion of the land acquired by the Commission consisted. Sufficient here to say that great success was attained in some regions by the employment of tractor ploughing. The great increase in mechanization in connexion with farm implements of all types enabled the Commission to devise, and the makers to construct, a tractor plough of such power that areas of deep peat, hitherto beyond the ability of man to cultivate in any way, are now turned up into deep furrows and ridges, enabling drainage to be given to the area while the young trees are planted on the ridges. Continually increasing areas of such lands are being afforested, and it is a sight well worth visiting, whether from a scientific or popular point of view.

Other experiences likely to be of considerable interest to the scientific man are the investigations which have had to be taken up at short notice in connexion with pests. In the early years, great hopes were placed on the Douglas fir, but a *Chermes* appeared on it and threatened young plantations wholesale. The *Hylobius* weevil was a well-known pest, but although in Prussia chiefly confined to Scots pine, the extended work of the Commission showed that the weevil would attack several of the exotic coniferous species being used. The interest of this work lies in what is becoming a recognized factor in planting work, whether agricultural or forestry, that a large and sudden extension on a countryside will invariably be accompanied by an increase in local pests, and not uncommonly the appearance of new ones.

Looking back over the past twenty-five years, it may be said that the Forestry Commission and its officers are to be congratulated on the work which has been accomplished in spite of often difficult obstacles. The public now participate as owners in a forestry estate which with adequate support, both financial and otherwise, will form a great asset to Great Britain, always provided that the growth of the hardwoods in their respective regions is not neglected, for some of them produce the finest timber of the temperate zone, while their beauty has made English scenery as enchanting as any the world can show.

NICOTINAMIDE METHOCHLORIDE AND ITS FLUORESCENT DERIVATIVES

By DR. P. ELLINGER

Lister Institute of Preventive Medicine, London

THE methylation of pyridine in the animal body was observed by His¹. When he showed that pyridine was converted to N-methyl pyridinium hydroxide and when Ackermann² found that ingested nicotinic acid was partly eliminated as trigonelline, these observations were at that time mainly of theoretical interest. They became of practical value, however, when nicotinamide was shown to be a constituent of the coenzymes I and II by Warburg and Christian³, Warburg, Christian and Griese⁴, and v. Euler, Albers and Schlenk⁵, and their significance became obvious when Knight⁶ demonstrated the importance of nicotinic acid as a growth factor in bacteria, and Elvehjem, Madden, Strong and Woodley⁷ showed the curative effect of nicotinic acid in canine black tongue and suggested its identity with Goldberger's PP factor, this fact was verified by numerous investigators. It was of considerable interest, therefore, when Najjar and Wood⁸ published their discovery that a whitish blue fluorescent substance was present in the urine of normal subjects and was increased in amount after the ingestion of nicotinamide and other related compounds.

The fluorescent material was demonstrated when a 'Decalso' adsorbate of urine was eluted with potassium chloride solution and the solution was made alkaline and extracted with butanol. The butanol extract showed fluorescence when exposed to the light of a mercury vapour bulb filtered through a Wood glass filter. In an attempt to identify the substance a large number of pyridine derivatives were examined, but none of them revealed the characteristic fluorescence when tested under similar conditions. The fluorescence spectrum in butanol was determined, a number of observations were made upon the stability and solubility of the fluorescent substance in butanol and a rough method of assay was devised by matching the fluorescence intensity of the butanol extract against that of a standard solution of quinine sulphate. Somewhat later, Najjar and Holt⁹ described a second substance that possessed a violet-blue fluorescence which became visible when the potassium chloride eluate of a urinary 'Decalso' adsorbate was extracted with butanol without adding alkali. This substance was called F_1 by the authors, while the substance observed after alkalinization was called F_2 .

The pigment F_1 was found in the urines of patients in the acute stages of pellagra and of black tongue dogs in which F_2 was more or less reduced. A number of theories were put forward about the nature of F_1 and F_2 and their function, and it was suggested that F_1 might be responsible for the photosensitivity of pellagrins. The fluorescence of F_1 was also characterized by its emission band. The administration of nicotinic acid to pellagrins and black tongue dogs caused a prompt reduction of F_1 and reappearance of F_2 ^{10,11}. The nature of F_1 is still unknown. A number of pyridine and pyrazine derivatives were tested for their power to increase F_2 , but nicotinic acid, nicotinamide and nikethamide alone were found to be active. These compounds were also known to be active in the cure of pellagra.

A violet fluorescent substance was reported by Singal and Sydenstricker¹² in the urine after ingestion of pyridoxine. The pigment is said to be present in the neutral butanol extract of a potassium chloride eluate of a urine adsorbate on 'Decalso'. Ellinger and Coulson¹³ were unable to confirm this observation, but Huff and Perlzweig^{14,15} succeeded in isolating the fluorescent material and identified it as 4-pyridoxic acid.

An attempt was made to use the elimination of F_2 by animals and man for the estimation of nicotinamide and related compounds in foodstuffs at the suggestion of Dr B. S. Platt. For this purpose dogs, ferrets and human volunteers were calibrated with nicotinamide and a preliminary method giving comparable but not absolute values was devised for the quantitative assay of F_2 in urine^{16,17}.

In order to develop an assay method providing absolute results, it was necessary to elucidate the chemical nature of F_2 . Attempts were made, therefore, to concentrate and purify the fluorescent pigment contained in the butanol or isobutanol extracts¹⁸. The purification was carried out with the aid of the ultra-violet absorption spectrum. The absorption spectrum, the fluorescence spectrum and the behaviour of the substance towards reducing agents, alkali and acid, were so similar to those of thiochrome that F_2 was thought to be a mixture of thiochrome and a whitish fluorescent substance. Differences in the adsorption on 'Decalso' of F_2 and thiochrome at different pH's later proved that this conclusion was incorrect¹⁹.

Two papers on the chemical nature of F_2 were published simultaneously by Najjar, Scott and Holt²⁰, and by Huff and Perlzweig²¹. The former authors concentrated and purified F_2 and examined the properties of the concentrate. They observed its fluorescence in presence of alkali and acid, and recorded its stability towards oxidation; they observed the irreversible formation of a violet fluorescence after treatment with alkali and potassium ferricyanide, of a yellow pigment with green fluorescence after treatment with alkali and acetone, and of a non-fluorescent orange-red pigment after the addition of sulphanilic acid. These workers proved that F_2 is a pyridine compound by producing a positive cyanogen bromide test after alkaline hydrolysis. They realized that there were similarities between F_2 and the reduction products of N-methyl nicotinamide, but were unable to identify F_2 with one of these products on account of certain discrepancies.

Huff and Perlzweig²¹ showed that animal species which were known to methylate ingested nicotinic acid eliminate increased amounts of F_2 after the ingestion of nicotinamide, while rabbits, which are unable to perform this methylation, do not eliminate F_2 after nicotinamide dosage. They claimed to have established the identity of F_2 with synthetic N-methyl-nicotinamide on the basis of the identity of the melting points and mixed melting point of the respective picrates. They concluded that " F_2 thus appears to be a N-methyl nicotinamide or a labile precursor which yields this compound in the course of isolation". Somewhat later²², they stated "A crystalline substance was isolated from human urine after dosage with nicotinamide. From comparison with synthesised N-methyl-nicotinamide chloride in regard to content of nitrogen, chloride and nicotinic acid, and in regard to the absorption spectra, fluorescence and the melting point of the picrate the two

substances were found to be identical. This establishes the identity of the fluorescent substance, F_2 , previously described by Najjar, Holt, and their collaborators¹⁷. They proved that most of the trigonelline found by earlier methods in animal urine after nicotinamide ingestion was in reality nicotinamide methochloride—a fact already made probable by Sarrett²³.

Ellinger and Coulson^{19,24} also attempted to determine the chemical nature of F_2 , and examined isobutanol extracts that had been evaporated at 60°. The material revealed the presence of at least five different fluorescent substances which could be separated chromatographically or by fractionated sublimation. When the concentration and purification of natural F_2 or of the fluorescent derivative of synthetic nicotinamide methochloride was carried out at room temperature, however, chromatographic adsorption analysis revealed the presence of only two fluorescent compounds, which were called F_{2a} and F_{2b} .

Up to that time, it was generally believed that F_2 was eliminated in the urine as a fluorescent pigment. This erroneous conclusion was responsible for much unnecessary work and gave rise to considerable confusion, which with certain workers still persists. Keresztesy²⁵, for example, still speaks of the fluorescent F_2 appearing in human urine. Ellinger and Coulson¹⁹ showed that when examined in the light of the 366 and 311 mμ mercury lines, neither the potassium chloride eluate of an adsorbate of urine on 'Decalco' nor that of an aqueous solution of nicotinamide methochloride is fluorescent, but that both become slightly fluorescent when made alkaline and that the fluorescence becomes more intense when the alkaline substance is extracted with isobutanol. Huff and Perlzweig²⁶ discriminated for the first time between the fluorescent F_2 and its non-fluorescent precursor in a paper published in 1944, in which they claim that their original investigation was concerned with the non-fluorescent precursor of F_2 and not as indicated in their earlier publications^{21,22} with the fluorescent derivative. The comparison by Ellinger and Coulson^{19,24} of a number of properties of the non-fluorescent precursor of F_2 and of synthetic nicotinamide methochloride, such as melting points of picrates and mercury iodides, absorption spectra, behaviour towards treatment with alkali and isobutanol, absorption and emission spectra of the fluorescent derivatives showed the complete identity of the two compounds. The only difference observed was that in the melting points of the aurates. It is to be noted, however, that aurates with different melting points and gold content were observed for trigonelline by Jahns²⁷, and, therefore, a difference of this kind cannot be accepted as indicating that the two compounds are different. A different gold content was observed, indeed, for the aurates of the natural precursor of F_2 and the synthetic nicotinamide methochloride, and three aurates could be obtained from the latter differing in colour, crystal structure and melting point (Ellinger²⁸).

The careful analysis of the behaviour of both the natural non-fluorescent precursor of F_2 and the non-fluorescent nicotinamide methochloride after treatment with alkali and isobutanol revealed the following facts. In aqueous solution, when examined in the beam of the 366 mμ and 311 mμ mercury lines, both substances are non-fluorescent. After the addition of alkali a weak whitish-blue fluorescence develops which can be extracted with isobutanol and increases

as much as 400 times in intensity when in isobutanol. The absorption spectra of the non-fluorescent precursor of F_2 and of nicotinamide methochloride show maxima at 264 mμ, recorded by Huff and Perlzweig²² for F_2 and nicotinamide methochloride. The absorption spectra of F_2 and of the synthetic nicotinamide methochloride derivative obtained after alkali and isobutanol treatment showed maxima at 358 mμ. The addition of alkali to the precursor of F_2 or synthetic nicotinamide methochloride in aqueous solution causes practically no change in light absorption.

These facts lead to the conclusion that alkalization causes a change in the nicotinamide molecule. By analogy with the findings of Hantzsch and Kalb²⁹ and of Decker and Kaufmann³⁰, a migration of the OH group from the pyridine N to one of the pyridine C atoms with simultaneous loss of one double bond in the pyridine nucleus and formation of carbinols was suggested. The low fluorescence intensity and the practically unchanged absorption spectrum in aqueous solution after alkalization showed that in water the equilibrium between the quaternary pyridinium base and the carbinols was in favour of the former, while the high fluorescence intensity and the almost complete change of adsorption spectrum in isobutanol indicates a reversed equilibrium in the latter solvents.

Adsorption on aluminum oxide of the purified F_2 as well as of the fluorescent derivative of nicotinamide methochloride and elution with isobutanol and methanol, respectively, revealed the presence in F_2 of two fluorescent compounds, F_{2a} and F_{2b} , each possessing different absorption and emission spectra. The form of their absorption spectra and the similarity with dihydro derivatives of nicotinamide described by Warburg and Christian³, Warburg, Christian and Giese⁴, and Karrer, Schwarzenbach, Benz and Solmsen³¹ lead to the conclusion that F_{2a} was probably the γ-carbinol, and F_{2b} an α-carbinol of N-methyl dihydronicotinamide. In the light usually employed, which is derived from a mercury vapour lamp filtered by Wood glass, the emission spectrum of F_2 is almost identical with that of F_{2b} , since the primary light consists mainly of the 366 mμ lines which are strongly absorbed by F_{2b} but very little by F_{2a} .

Perlzweig, Bernheim and Bernheim³² made the important observation that nicotinamide but not nicotinic acid is methylated *in vitro* by liver, but not by kidney, or muscle slices of rats. Usually, but not always, this methylation of nicotinamide is increased by addition of methionine or choline. The methylation process requires the presence of oxygen and intact living cells.

Further observations on the nature of F_2 were published by Najjar, White and Scott³³, and by Najjar and White^{34,35}. In the last two communications^{34,35}, Ellinger and Coulson's¹⁹ original observations that the metabolite of nicotinamide was non-fluorescent and became the fluorescent F_2 by treatment with alkali and isobutanol was confirmed, whereas in the earlier paper³³ no discrimination was made between F_2 and its non-fluorescent precursor. Najjar, White and Scott³³ describe the preparation of a purified F_2 concentrate as a waxy material from which crystals were obtained by treatment with ethyl acetate, water, or methanol. A number of properties of these crystals were described. The absorption maximum of the fluorescent F_2 is described as at 264 mμ, which corresponds to that found by Ellinger and Coulson¹⁹ for the aqueous non-fluorescent precursor, the maximum for the fluorescent F_2 iso-

butanol solution was found by Ellinger and Coulson to be at 358 m μ . Alkaline hydrolysis of the crystalline material afforded a product giving a cyanogen bromide reaction. Najjar and co-workers^{33,34,35} accept the conclusions of Ellinger and Coulson¹⁹ that the development of fluorescence from the non-fluorescent nicotinamide methochloride or the precursor of F_2 by alkalinization and treatment with butanol is due to a rearrangement of the quaternary base into a carbinol, but they believe that F_2 is a carbinol-*isobutanol*-ether. This conclusion is based on the following facts: (a) that the fluorescence of the alkaline aqueous solution is greatly increased by the addition of small amounts of *isobutanol* enough to saturate the aqueous layer, but insufficient to cause a separation of the two layers, (b) that the fluorescence intensity of the *isobutanol* layer increases while standing. The carbinol-butanol-ether is said to break down when evaporated to dryness. An elementary analysis of the crystals yielded values for nitrogen which correspond to about half the amount theoretically required.

The evidence for F_2 being a carbinol-butanol-ether would appear to be inadequate, since the increase of fluorescence on addition of *isobutanol* to the alkalized aqueous nicotinamide methochloride solution is fully explained by the fact that a considerable amount of *isobutanol* favouring the carbinol phase is dissolved in water. This increase in fluorescence intensity is observed when a number of solvents of F_2 , such as methanol, ethanol, amyl alcohol, ethyl acetate (some of them being miscible with water) are added to the alkalized aqueous solution of nicotinamide methochloride or of the precursor of F_2 , but not when organic solvents are added which do not dissolve F_2 , such as ether, petrol ether, pentane, chloroform (Ellinger²⁸). The increase in the fluorescence intensity on standing is explained by the fact that the rearrangement of the quaternary base into the carbinol, induced by the equilibria in aqueous and butanol solutions and the relative solubility of the carbinol in the two layers, is a slow process. Under the conditions used in the assay method as described by Coulson, Ellinger and Holden³⁶, maximum fluorescence of the butanol layer is reached after thorough shaking for five minutes.

There is one experimental fact against the acceptance of the idea that F_2 is a carbinol-butanol-ether. The pigment F_2 can be developed by treating the aqueous alkaline solution of nicotinamide methochloride or of the precursor of F_2 with ethyl acetate in place of butanol²⁸. It seems improbable that ethyl acetate is able to form a carbinol-butanol-ether or a corresponding ether with the carbinol. The fluorescence in the ethyl acetate layer is less intense than in butanol owing to a lower partition coefficient (Ellinger²⁸).

Najjar and co-workers^{33,34,35} stress the apparent discrepancy between nicotinamide methochloride and the non-fluorescent precursor of F_2 , and employ for this purpose the findings of Coulson and Ellinger²⁴ that different aurates are formed from the two products. However, as has already been pointed out, aurates with varying gold content are formed also from trigonelline. Najjar and White³⁵ produce additional evidence in support of their conclusion that the two substances are dissimilar. The precursor of F_2 is said to show a weak bluish fluorescence, and the urinary precursor of F_2 is said to differ when different anti-pellagic agents are ingested. Remeckates obtained from urinary eluates after the ingestion

of nicotinic acid and of nicotinamide are also said to show significant differences in melting points. No crystalline picrate was obtained from the precursor of F_2 recovered after nicotinic acid administration. The weak fluorescence of the urinary precursor of F_2 would appear to contradict the findings of Ellinger and Coulson¹⁹ and of Huff and Perlzweig²⁸. The absence of any specific details of the exciting beam used by Najjar and White³⁵ makes it necessary to assume that Wood glass filtered mercury light was used, that is, a light consisting of about 90 per cent of the 366 m μ and 10 per cent of the 311 m μ lines. If the absorption spectrum of the precursor of F_2 as found by Ellinger and Coulson¹⁹ and by Huff and Perlzweig²⁸ for ' F_2 ' is correct, then the precursor of F_2 cannot be 'fluorescent' under the conditions of the experiment, since the 366 m μ and 311 m μ lines are not absorbed by the aqueous solution. The fluorescence observed by Najjar and White is probably due to impurities. Picrates possessing identical melting points have been found by Ellinger²⁸ from the precursors of F_2 after ingestion of nicotinamide, nicotinic acid, and nikethamide by a human subject. The occurrence of two different Remeckates may be due to the same cause as that of two different aurates. There is at present no evidence for the non-identity of the urinary precursor of F_2 and nicotinamide methochloride and for different F_2 precursors after the ingestion of nicotinamide and nicotinic acid.

Najjar and co-workers^{29,37} have attributed a considerable biological activity to nicotinamide methochloride. It is considered to be a growth factor for *E. coli* and *H. influenzae* and an efficient agent in preventing and curing nicotinamide deficiencies in hamsters and dogs.

The interference with the estimation of aneurin by the thiochrome method by the formation of a bluish fluorescent derivative of the nicotinamide methochloride simultaneously present during the treatment with alkali and ferricyanide was observed by Najjar and Ketron³⁸, and a method was devised to avoid this error. This bluish fluorescent pigment was called F_3 by Coulson³⁹, who considered it to be most probably a N-methyl pyridone derivative of nicotinamide. It seems probable that the same substance was obtained by Ellinger²⁸ from F_{2a} , but not from F_{2a} , by treatment with alkaline ferricyanide. Coulson³⁹ also devised a method for simultaneous determination of aneurin and nicotinamide methochloride.

In addition to the earlier methods, three quantitative procedures for the estimation of nicotinamide methochloride have been devised, by Huff and Perlzweig⁴⁰, by Coulson, Ellinger and Holden³⁶, and by Najjar⁴¹. With the help of these improved methods, a clearer insight was gained concerning the metabolism of nicotinamide in normal persons and its changes in certain diseases (Ellinger and Coulson¹⁸). Only 10-15 per cent of ingested nicotinamide is eliminated as nicotinamide methochloride in the urine by normal persons after a single ingestion, thus it must be emphasized that about four-fifths of the ingested nicotinamide cannot be accounted for³⁸. It remains to determine whether nicotinamide methochloride is the only metabolite of nicotinamide in man and animals which methylates pyridine derivatives, or whether other metabolites such as trigonelline can be found, especially after the ingestion of nicotinic acid.

Ellinger and Coulson¹⁸ examined the effect of the ingestion of nicotinamide, nicotinic acid and other

nicotinamide derivatives on the daily elimination of nicotinamide methochloride, studied the intrinsic and extrinsic factors influencing this elimination and discussed the mechanism of the formation of nicotinamide methochloride. From the relation of the eliminated nicotinamide methochloride to the dietary nicotinamide intake, they suspected the presence of an extra-dietary source of nicotinamide. This supposition was proved to be correct by Ellinger, Coulson and Benesch^{42,43}, who showed that a considerable proportion of the human requirements of nicotinamide can be due to the production of this substance by the intestinal flora, a fact which throws new light on the etiology of pellagra and other nicotinamide deficiencies. Nicotinamide elimination in pellagra was studied by Holt and Najjar⁴⁴, Roberts and Najjar⁴⁵ and Ellinger and Benesch⁴⁶, they found lower elimination of the F_2 precursor in pellagrins than in healthy persons, both untreated and after single and repeated administrations of nicotinamide. A change of these 'saturation curves' was also observed in certain liver diseases (Ellinger and Benesch⁴⁶). Evidence was obtained that ulcerative gingivostomatitis was not due to a nicotinamide deficiency (Coulson, Ellinger and Smart⁴⁷).

'Fluorescence' throughout this paper always means fluorescence in the visible region produced by the primary light used usually for this purpose, namely, long-wave ultra-violet, especially the 366 m μ and 311 m μ mercury lines. It is quite possible that aqueous solutions of nicotinamide methochloride emit fluorescence in the ultra-violet region when excited with rays of about 260 m μ . To investigate this point more complicated instruments, a quartz monochromator and an ultra-violet spectrograph are necessary. When fluorescence is mentioned, the absorption spectrum of the substance in question and the wave-length of the exciting beam should be given to explain whether under the conditions of the experiment fluorescence can be produced. To characterize the fluorescence qualities of a substance the 'fluorescence efficiency', that is fluorescence intensity per absorbed light quant (Wawilow⁴⁸), should be given in addition to the exciting wave-lengths and the absorption spectrum. Since absolute values of the fluorescence efficiency are difficult to obtain, it is advisable to relate the measured fluorescent intensity when half the exciting light is absorbed to that of an aqueous quinine sulphate solution of the same molar concentration under the same conditions as standard. The knowledge of the fluorescence efficiency makes it possible to judge whether changes of fluorescence intensity which occur frequently, for example, by alterations of pH, are due to a shift of the absorption band or to a change in fluorescence efficiency.

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'RUBBER ACID' DAMAGE IN FIRE HOSES

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IN a brief reference, Crosby, Fiske and Forster¹ mention that a common cause of hose failure in rubber-lined fire hoses may be due to sulphuric acid formed from sulphur present in hoses when these are not properly dried. Such damage, apparently, was almost unknown in Great Britain before the War, but has recently been much in evidence. According to Phillips², 'rubber acid' is produced, and its damage observed chiefly in fire stations which lack adequate draining and drying facilities. It would appear to affect primarily, if not exclusively, rubber-lined fire hose.

When rubber-lined hose is stored after use, without preliminary draining and drying, there is invariably left in it a certain amount of water, and when such hose is examined during storage, it is found to contain a liquid, commonly the amount is no more than a quarter of a pint. This liquid is not infrequently discoloured brown. It is often slightly turbid and

markedly acid, the degree of acidity tends to increase with duration of storage. On examination the acid proves to be sulphuric.

When rubber acid is accidentally spilt over the canvas surface of the hose, or over any other cellulosic fabric, rapid tendering occurs, a process which becomes accelerated with the drying off of the fabric. When spilt over a concrete floor the rubber acid may cause corrosion of the floor surface and evolution of carbon dioxide gas bubbles.

Phillips² has given some data illustrating the importance of the damage caused by rubber acid to the hose, and as an immediate remedy advocated thorough draining of the hose after use. In a subsequent communication³, Phillips *et al* describe an examination of three hundred hose bursts, representing damage throughout Great Britain. More than 50 per cent of these bursts were due to rubber acid damage. They record also that rubber-lined hose of British, Canadian and American origin are equally subject to the fault, and that the concentration of sulphuric acid found in the hose liquor may reach a figure of about 1 per cent.

Phillips *et al* state that the opinion has been advanced that acid production is due to the inclusion in the hose rubber of an excessive amount of free sulphur, which in the presence of water and air becomes oxidized to yield sulphuric acid. However, the well-known resistance of elemental sulphur to auto-oxidation at atmospheric temperatures seemed, on the face of it, to preclude this explanation. On the other hand, micro-organisms had been observed in numerous samples of hose liquid, and since there is well-established evidence to show that in the presence of certain micro-organisms, elemental sulphur can be oxidized to sulphuric acid at atmospheric temperatures, it was logical to keep this possibility in view and to ask the Chemical Research Laboratory to examine it.

The initial samples of hose liquor were drawn under aseptic conditions from rubber-lined hoses from three fire stations in the Kingston (Surrey) district.

Details of these samples are given in Table 1.

TABLE 1

Station	Sample No	Appearance of liquid	Reaction of liquid to litmus	pH of liquid	Date hose last used
A	1	Colourless	Neutral	7.1	2 days previously
	2	Faintly discoloured and turbid	Neutral to only slightly acid	7.0	2 days previously
	3	Strongly yellow and turbid	Acid	1.0	At least 6 months
B	4	Colourless	Neutral to only slightly acid (about 1 gallon)	7.0	At least 7 days
	5	Colourless and somewhat turbid	Neutral to only slightly acid (about 1 quart)	7.1	At least 7 days
C	6	Brown	Acid	1.0	At least 1 month

The presence of micro-organisms in the various samples was confirmed both by direct microscopic examination and by cultivation on ordinary nutrient agar, wort agar and thiosulphate agar, the latter being a medium free from organic substances and recom-

mended by Waksman⁴ for the cultivation of sulphur-oxidizing bacteria.

The microflora taken from the six samples of rubber acid and found capable of growth on ordinary nutrient agar comprised several forms, all of them with their natural habitat in soil and water. Their numbers ranged between two and fifteen million cells per ml of hose liquor, except in sample 6, where they were completely absent. The highest number occurred in sample 2. None of them was of a type capable of oxidizing elemental sulphur.

On wort agar only four types of fungi developed: a black fungus so far unidentified, another with white mycelium, possibly a *Cephalosporium* species, a black *Dematium* species and a pink *Torulopsis* species. Their numbers did not exceed 70,000 cells per ml in any of the rubber acid samples, and were no more than 20 per ml in sample 6.

The *Cephalosporium* species was found in samples 1 and 2, the unidentified fungus in samples 3, 4, 5 and 6, the *Dematium* species in samples 1 and 4 and the pink *Torulopsis* species in sample 4. Only the black fungus, therefore, could have been associated with acid production. However, since it did not appear on any of the thiosulphate agar media, it is unlikely, to say the least, to have played a major part in sulphur oxidation.

The organisms which grew on the thiosulphate agar were restricted to no more than five types, all of them short, non-spore-forming rods. Their numbers in the various acid samples were very much of the same order, ranging from 13 to 19 million cells per ml of hose liquor, except in sample 6 where only 5 million cells were counted.

Each of these types was tested for its sulphur-oxidizing power by inoculating it into a medium containing inorganic salts and free sulphur. On this medium only two of them, isolated from hose liquor samples 3 and 6, grew rapidly, and in less than a week rendered the liquid turbid and acid, with a drop in the original reaction of the medium from pH 4.6 to pH 1. The acid produced was identified as sulphuric acid. Of the remaining types of short rods growing on thiosulphate agar, it should be mentioned that they grew well also on ordinary nutrient agar. Those from liquors 3 and 6, which produced acid from elemental sulphur, did not do so.

The remaining four samples of hose liquid, from which sulphur-oxidizing bacteria had not been isolated by the direct method employed, were inoculated into an inorganic liquid medium containing free sulphur. It was suspected that the failure to isolate sulphur-oxidizing bacteria from these samples might have been due to their containing too few cells. By introducing the original hose liquors into a medium specially adapted for the growth of sulphur-oxidizing bacteria, it was hoped to increase their numbers and thus to facilitate their isolation. However, after incubation of the inoculated special media for 14 days at 30°C only one of these, that inoculated with hose liquor No 4, gave rise to acid. From this sample it was possible to isolate typical sulphur-oxidizing bacteria. The others remained unchanged in reaction and showed no growth of micro-organisms. It is probable, therefore, that these samples Nos 1, 2 and 5 had not contained the organisms looked for.

It had been possible, therefore, to isolate sulphur-oxidizing bacteria from only 50 per cent of the hose liquors examined, implying either that these organisms may not be necessary for acid formation, or that these samples of liquors in which the organisms had

not been found, and presumably had not been present, would have failed to become acid in any event. On the available information it is not possible to decide which of the two alternatives is correct, though one deduction that can be made from the collected data seems to point in favour of the latter explanation.

The inconclusiveness of the results thus far obtained, which incidentally were unlikely to be improved upon by an analysis of further samples of hose liquor, made it desirable to test the hypothesis of a microbiological origin of rubber acid from a different angle, and to establish whether water introduced into rubber-lined hose would invariably become acid, if it contained sulphur-oxidizing bacteria.

An experiment was set up for this purpose in which tap water containing sulphur-oxidizing bacteria was introduced into sections of hose about 2 ft long. Sections from three hoses were chosen, two from new hoses and the other from a hose already in service which had developed rubber acid. Each section was bent in the shape of a U and into each, 25 ml. of test water, containing test bacteria, were introduced. The sections were then closed with clamps to reduce evaporation and incubated at room temperature. Each section was opened daily to admit oxygen and also shaken to keep the inner rubber surface wet. As control, a sterile section was taken from each hose. Into each of these, 25 ml. of sterile tap water was introduced, but no bacteria.

Table 2 shows the rate of change in pH values of the water contained in the various sections during 14 days of incubation.

TABLE 2

CHANGES IN pH VALUES OF WATER KEPT IN RUBBER-LINED FIREHOSES

No	Description	pH of water after incubation for			% of free sulphur in hose
		0 days	1 day	14 days	
1	New hose (sterile)	7.4	7.4	7.4	0.2
1a	" " + sulphur-oxidizing bacteria	6.0	6.2	1.6	0.2
2	New hose (sterile)	7.4	7.4	7.4	<0.1
2a	" " + sulphur-oxidizing bacteria	6.0	6.2	6.2	<0.1
3	Old hose (sterile)	7.4	7.4	7.4	0.1
3a	" " + sulphur-oxidizing bacteria	6.0	6.4	2.7	0.1

There is an interesting deviation in the expected results tabulated in Table 2. One of the new hoses apparently did not respond as expected to the presence of sulphur-oxidizing bacteria. This was a hose in which the free sulphur present amounted to less than 0.1 per cent. Apart from this it was possible to confirm that the presence of sulphur-oxidizing bacteria is essential for the production of acid hose liquor.

In a further experiment with sections of the No. 2 new hose in which, in addition to sulphur-oxidizing bacteria, free sulphur was added to the water introduced into a sterile section, it was possible to show that the failure of acid production was due not to any inhibitory properties possessed by this hose, but to the presence of insufficient free sulphur. For in this additional experiment the pH value of the water contained in the section dropped to below 1.2 in the course of 14 days.

It is clear, therefore, that there are two factors governing acid production in hose: first the presence or absence of the relevant bacteria, and secondly,

the presence of a sufficiency of free sulphur. This latter apparently should not fall below 0.1 per cent, calculated on the rubber lining. If the figures of Table 2 may be taken as substantially correct, acid production will be proportional to the percentage of sulphur present, other factors being favourable.

The presence or absence of sulphur-oxidizing bacteria will probably be governed largely by the type of water passing through hose when in use; and it was thought relevant, therefore, to examine fire-fighting water supplies for the presence of these organisms.

On inquiry it was found that much of the water available to the National Fire Service in the London district is taken from static supplies, these being replenished from the River Thames, or from local canals and ponds. Water taken direct from the mains is not used when other supplies are available.

An analysis of twenty-five samples of water from different sources of supply, including mains water, revealed that thirteen contained sulphur-oxidizing bacteria. Only two of the samples of mains water out of six examined contained these organisms. The percentage, therefore, of the crude waters used which contained these bacteria was no less than 58 per cent. The observation may perhaps give a clue to the frequency with which rubber acid is likely to be found in hose.

The presence of sulphur in rubber-lined hoses was found on inquiry to vary very considerably. Pre-war hose specifications, according to Phillips (*l.c.*), limited the free sulphur content in hose lining to 1 per cent in Great Britain and to 1.25 per cent in the United States. But these data are not a reliable guide, for recent analyses of twelve American samples showed the content to vary between 0.06 and 0.7 per cent. Similar variations are likely to occur in hose made in Britain and in Canada. From the data given in Table 2 it would appear that a free sulphur content of 0.1 per cent is sufficient to produce some acid, and that 0.2 per cent causes marked acid production. A permitted minimum of 1 per cent of free sulphur is therefore a gross excess, and can be expected to lead to acid production whenever the appropriate bacteria are present.

Conclusions The conclusions to be drawn from the experiments which have been carried out would appear to be that

The production of rubber acid in hose is due to the activity of sulphur-oxidizing bacteria of the *Thiobacterium thiooxidans* group.

Such acid will invariably be formed in rubber-lined hose which is stored with the linings wet, when the responsible bacteria are present and when the free sulphur content of the hoses exceeds 0.1 per cent.

If acid production is to be prevented, it is necessary to ensure, either that the rubber-lined hose is stored dry, or that its content of free sulphur is less than 0.1 per cent.

The alternative of preventing the introduction of the causal bacteria does not appear practicable, since the water used in fire-fighting is a frequent habitat of these bacteria.

In a series of additional experiments it was established that various organic sulphur compounds, commonly used in the vulcanization of rubber, failed to give rise to acid production, even in the presence of sulphur-oxidizing bacteria.

Thanks are due to the officers and men of the National Fire Service, and especially to Company Officer W. E. Gage, Hose Officer, No. 38 Fire Force,

who assisted us in obtaining the necessary experimental material and certain data required for this investigation. The work was carried out on behalf of the Director of Scientific Research, Ministry of Home Security, and is published with the approval of the Department of Scientific and Industrial Research and the Ministry of Home Security.

¹Crosby, Fiske, Forster, "Handbook of Fire Protection", 253, 9th edit (1941) (National Fire Protection Association, Boston, Mass.)

²Phillips, E. W. J., unpublished information (1943).

³Phillips, E. W. J., *et al.*, unpublished information (1944)

⁴Waksman, S. A., *J. Bact.*, 7, 605 (1922)

OBITUARIES

Lord Dawson of Penn, P.C., G.C.V.O., K.C.B., K.C.M.G.

THE death on March 7 of Lord Dawson at the age of seventy-nine has removed from the ranks of the medical profession one of its most eminent members. Lord Dawson symbolized in his own person the many different services the profession can render to the community. He had been physician to several members of the Royal Family. He was the perfect consultant combining hospital appointments with private practice, always at the service of his patients at whatever inconvenience to himself. To the House of Lords, to which he was elevated in 1920, he brought fine qualities of statesmanship and oratory, and he did invaluable work there in presenting to the public the medical point of view. His scientific eminence was reflected in the many honours conferred on him by universities and medical societies all over the world.

Lord Dawson was a prolific writer and lecturer on a wide variety of medical subjects. He took a prominent part in the organization of the medical services and the famous Dawson Report, produced under his

chairmanship by the Consultative Council on Medical and Allied Services appointed at the time of the creation of the Ministry of Health in 1919, is a milestone in the history of medical services. If the Government had acted upon the advice offered in that Report we might have been saved many of the problems the profession is facing to-day. Lord Dawson's wisdom in guiding the domestic affairs of his profession was recognized by his election to the presidency of the Royal College of Physicians during 1931-38 and to the presidency of the British Medical Association in its centenary year in 1932. He was recalled to the presidency of the British Medical Association in 1943 to lead the profession in the present critical stage of the development of the medical services of Great Britain.

To all his work Lord Dawson brought a rare vigour and wisdom and sympathy. He saw the practice of medicine as a means of making people healthy and happy. His charm and courtesy endeared him to all with whom he came in contact, both professionally and socially, and his pervasive influence will be sorely missed by the medical profession and the scientific world.

WE regret to announce the following deaths:

Sir Charles Bell, K.C.I.E., C.M.G., an authority on Tibet, aged seventy-four.

Sir George Humphreys, K.B.E., formerly chief engineer to the London County Council, president in 1930 of the Institution of Civil Engineers, on March 9, aged eighty-one.

Sir Hanns Vischer, C.M.G., C.B.E., honorary secretary-general of the International Institute of African Languages, on February 19, aged sixty-eight.

Prof. H. H. Whetzel, professor of plant pathology in Cornell University, on November 30, aged sixty-seven.

NEWS and VIEWS

Helium for the Royal Society Mond Laboratory

THE National Research Council of Canada has recently made a gift of 2,000 cubic feet of helium gas to the Royal Society Mond Laboratory at Cambridge. This amount of gas will enable the Laboratory to recommence research on very low temperature problems and on a scale which will allow the full resources of the Laboratory to be employed. In the whole field of physics, the temperature region close to the absolute zero remains one of the most fruitful for investigation. The low-temperature problems which received most attention before the War were those of superconductivity, magnetic cooling and the properties of liquid helium itself. These are, however, only the more prominent aspects of a wider field of investigation. Many mechanical, electrical, magnetic and optical phenomena, which are either partially or completely obscured by thermal agitation at room temperature, stand out clearly and undisturbed in the quiet region from 5° absolute down to 0.01° absolute which is attainable with liquid helium.

Grants for Scientific Investigations and Publication

THE Royal Society has now been informed that the Treasury has made provision in the estimates for the fiscal year 1945-46 for the following grants which are

administered by the Royal Society: for scientific investigations, £14,000; for scientific publication, £7,000; for scientific congresses, £1,600. In view of the greater amounts to be available if these estimates are accepted by Parliament, and of present changing conditions, the Royal Society has decided that more frequent allocation is desirable. The last dates, therefore, in 1945, for receiving applications for grants from the Parliamentary Grant-in-Aid for Scientific Investigations will be March 31, July 31 and November 30, and the last dates for receiving applications for grants from the Parliamentary Grant-in-Aid for Scientific Publication will be June 15 and November 15.

Cosmic Ray Studies in the Pamirs

A GROUP of scientific workers from the Lebedev Institute of Physics, Moscow, has left for the Pamirs to study the composition of cosmic rays at high altitudes. The expedition is under the direction of Prof. Skobeltsyn, of the U.S.S.R. Academy of Sciences, and will continue studies that have been carried on for several years on Mt. Elbrus by workers from the Atomic Nucleus Laboratory. The main object of the expedition is to determine the part played by heavy particles and secondary mesons first discovered in the study of cosmic radiations in 1937. Cosmic

radiations have two sharply defined components—a hard component consisting of mesons possessing great energy and a soft component including positrons and electrons. It is known that the soft component, at any rate at sea-level, is genetically connected with the hard component, being apparently generated by the latter. At great altitudes the presence of an unbalanced component has been discovered, namely, radiation that is not directly connected with the hard component. The study of cosmic radiations at great heights is therefore of great importance for the understanding of cosmic radiations as a whole. The question of secondary mesotrons and other strongly ionized agents causing ionization impulses is of great interest. The problem of the generation of secondary mesotrons has gained in significance in recent times.

In order to study mesons, the expedition will make use of an improved form of 'proportional telescope'. In studying cosmic rays at great heights, they will take into consideration 'atmospheric rain', a phenomenon of cosmic rays discovered by a French physicist, P. Auger. Skobeltsyn has studied all the available experimental data, especially those obtained in the Elbrus Laboratory, and has come to the conclusion that a considerable proportion of the impulses are due to processes other than 'Auger's rain'. The expedition will try to prove this by the method of coincidences. An important part of the work of the expedition will be the study of the transition effects of the soft component, that is, the processes which occur when rapid protons and electrons leave matter with one atomic weight and enter the orbit of substances with a different atomic weight. The cycle of studies devoted to these particular effects, which was begun before the War, will be continued, employing greatly improved methods which the Atomic Nucleus Laboratory has recently evolved.

Educational Needs in Liberated Countries

THE sixteenth meeting of the Conference of Allied Ministers of Education was held on March 7 under the chairmanship of the Right Hon. R. A. Butler. The Belgian Minister of Education, M. Buisseret, made a special visit to London in order to attend. Mr. Butler stated that considerable progress has been made towards the establishment of a United Nations organization for educational and cultural reconstruction, and it was announced that it would be possible, after the San Francisco meetings, to make proposals for the final constitution of the new organization. M. Buisseret presented a statement to the Conference stressing the difficult position which has resulted from the Nazis' forceful educational propaganda among teachers and in schools, especially in the small, mainly German-speaking areas of Belgium, which in the course of the occupation had been annexed to Germany. It was pointed out that similar problems might arise in other countries which had suffered occupation. The Conference was informed that a new Commission has been formed "to collect information from liberated countries and elsewhere about the educational needs of, and the work being done for, children and young people requiring special educational treatment, to make the necessary contacts with other bodies engaged on similar activities and to make recommendations to the Conference as to how the information can best be made available and assistance given if desired to the Allied Governments." Mr. J. A. Lauwerys has been appointed to direct the inquiry, and will have his headquarters at 3-5 Salisbury Square, London, E.C.4. The Con-

ference adopted the following resolution, and decided that it should be communicated to the Allied Governments through their delegations: "The Conference of Allied Ministers of Education, having considered reports from liberated territory, record their unanimous view that, the need for the supply of raw material for educational purposes, and in particular for school books, is of paramount importance. Unless such supplies are made available the Conference believes that the resumption of educational activities will be greatly delayed and additional hardship for the children, students and parents in liberated territories will result."

Restoration of Libraries

UNDER the auspices of the Conference of Allied Ministers of Education, a committee has been set up to administer the organization and premises known as the Inter-Allied Book Centre, 3-5 Salisbury Square, London, E.C.4, where books can be received and systematically arranged for ultimate allocation to libraries in Great Britain and abroad which have been damaged or destroyed during the War. Already more than a million books, ranging over the whole field of knowledge, have been set aside, by action of the Government, from collections made primarily for salvage purposes. The collection includes books of every kind, but the proportion of modern technical, scientific, commercial and legal works is low. Many libraries will urgently need sets of the more important periodicals, particularly the back numbers of journals and transactions. Those unable to give books or periodicals can support the general scheme by money contributions, which will be used entirely for the purchase of books and periodicals, but so many books have been destroyed, or are in short supply, that the need is for books rather than money. It is generally thought that the committee of allocation should have a free hand to decide the ultimate destination of all books received, but if a donor urgently desires to give to a particular country, or even a particular library, he is asked to communicate with the director of the Book Centre. Bodies which are already collecting books for specific countries or institutions are asked to supply the director with lists of books and periodicals which they propose to distribute, so that they can be taken into account by the Centre in making its own distribution. Donors are asked to send to the director of the Centre, Mr. B. M. Headicar, lists of the books available, carriage will be refunded, if desired, on all books presented.

Royal Institute of Chemistry

AT the sixty-seventh annual general meeting of the Royal Institute of Chemistry held on March 12, at the Institute, 30 Russell Square, W.C.1, Prof. Alexander Findlay, the president, in moving the adoption of the annual report, emphasized the growing opportunities for men of science to bring about a better balance between science and politics and between knowledge and power. The tasks of Government and the formation of a national and international policy which will secure the fullest and most complete development and expression of human nature, when beauty and goodness merge and blend together with truth, depend in part on values other than the scientific, and involve problems which cannot be solved merely by the application of the laws of natural science. But in securing the material well-being of the people and in advancing industrial pro-

perity, science is all-important and, in Prof Findlay's opinion, representatives of scientific institutions on the Parliamentary and Scientific Committee are playing a particularly important part in keeping the Government informed regarding the discoveries and applications of science to human and industrial well-being, and in providing a scientific method of approach to the problems of national administration, a method infused with the spirit of truth rather than of prejudice or party partisanship.

Prof Findlay stated that the roll of membership of the Institute has increased by 523 to 9,227, and the register of students by 205 to 1,225 during the past year. He also referred to the greater collaboration among the various organizations of chemists and the better co-ordination of their activities, in which representatives of the Institute have continued to play their part. He congratulated the Chemical Council on having gained from industrial firms and private subscribers greatly increased financial support for chemical publications. During the sixty years since the Institute was incorporated by royal charter, its membership has increased twenty-fold and there has also taken place remarkable expansion of the activities of chemists. The time has now come to reformulate its aims and interests and to adapt its organization so as the more effectively to achieve its aims and fulfil its responsibilities, proposals for modifying the charter and by-laws are to be laid before the members in due course. Reference was made to the retirement of Mr Richard B. Pilcher, who had been secretary for fifty years and for forty-five years registrar and secretary, and the appointment of Dr H. J. T. Ellingham as secretary and Mr R. L. Collett as registrar. Prof Findlay was re-elected president.

Pedigree of Fossil Man

PROF RUGGLES GATES has produced a very concise and interesting article on the pedigree of fossil man (*Amer J Phys Anthropol*, 2, No 3, Sept 1944). He reviews the opinions of others, discusses modern tendencies and viewpoints, and summarizes his own conclusions. So long as the data supplied relative to the finds of prehistoric man are reliable, the conclusions arrived at by the physical anthropologists must, of course, be treated with great respect. But unfortunately, really well-authenticated and documented discoveries of prehistoric skeletons are more than rare. For example, Prof Ruggles Gates says: "The evidence of the Committee which investigated the Swanscombe parietal and occipital shows that stratigraphically it is one of the best authenticated of all human remains, and geologically the evidence of the age of the gravels in which they were found is very complete." In the sense that the exact horizon whence came the bones is known, this is certainly true, but it is not enough, for in those Swanscombe gravels both Acheulean and Clactonian industries occur mingled. To say the least, it is still possible that the prehistoric folk who made the *coup-de-poung* industries were entirely distinct from those flake-tool makers who produced the Clacton, Levallois and other flake industries. A study of distribution maps strongly suggests that such a distinction should be made. Now the early flake-tool folk were the ancestors of the Mousterians, that is, of Neanderthal man, whereas the *coup-de-poung* makers appear to have quite another story—perhaps an African one—and it is thus still impossible to be certain to which of these two cultural facies the Swanscombe bones belonged. It is not until problems like this—

purely matters for the prehistorian to settle—are resolved that the physical anthropologist can satisfactorily do his job. Bearing in mind this warning note, Prof Ruggles Gates's paper makes interesting and informative reading. He is trying to give answers to just those questions many would like to have elucidated, among other interesting conclusions he places Neanderthal man, in accordance with Weidenreich, in the chain of development from *Pithecanthropus* and *Sinanthropus* to "the modern type of man". Not all anthropologists would agree.

Length of Small Intestine ✓

THE capacity of the human body to withstand remarkable injury or loss of what may seem to be essential organs is continually astonishing those who have to deal with injuries sustained in war and peace or with the results of surgical operations. C. C. Holman (*Lancet*, 597, Nov 4, 1944) has reported the instance of a woman who, having survived the removal of her uterus and of the breast for cancer ten and six years earlier respectively, had to sustain, at the age of fifty-six, the removal of twenty feet of her small intestine. A lateral anastomosis was performed between the jejunum and the transverse colon. The patient recovered and three months later had gained 2 lb in weight. A year after the operation she weighed rather more than before her operation and was doing the parish work as a clergyman's wife.

In an Annotation on this case, the *Lancet* says that people have survived, for several years at least, with only 3 ft of combined duodenum and jejunum and no ileum. It has been calculated (H. E. Haymond, *Surg Gynec Obstet*, 61, 693, 1935) that removal of up to one third of the total length of the small intestine could be followed by return to normal function, but that poor results might follow removal of more than half of it, or eleven feet in average people. It is pointed out, however, that the length of bowel removed gives no true indication of the length which remains, because the total length of small intestine varies between 10 ft and 28 ft 4 in, according to J. Bryant (*Amer J Med Sci*, 167, 499, 1924), who measured the small intestine at autopsy in 160 adults. When the gut is alive, it is a great deal shorter, possibly half the length measured at autopsy or less. Another case, reported by J. A. Cosh in the same issue of the *Lancet* (p. 596), was less fortunate. This was a man aged sixty-seven, from whom all the small intestine was removed except the duodenum and about 3 ft of the jejunum. For about eight months he had fairly good health, but then became ill and died twelve months after the operation.

Announcements

PROF BENGT EDLÉN, of Lund Observatory, Sweden, has been awarded the Gold Medal of the Royal Astronomical Society for the year 1945 for his identification of the origin of the principal lines in the coronal spectrum.

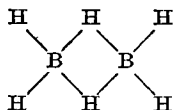
THE Council of the University of Sheffield has appointed Dr Harry Moore to the chair of glass technology in succession to Prof W. E. S. Turner, who is to retire at Christmas 1945, Dr H. A. Krebs to the newly created chair of biochemistry, and Mr A. E. Bender to be research biochemist in the Department of Pathology, to work in association with the Sheffield Radium Centre.

LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications.

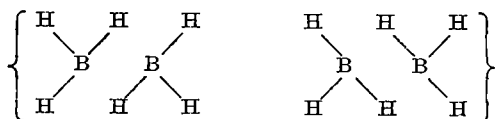
Structure of Boron Hydrides

As recently shown¹, the interpretation of polyatomic structures does not require the hypothesis of resonance among several idealized valence-bond structures, a speculative application of the quantum-mechanical conception of resonance, which is in disagreement with numerous facts. They are accounted for by the principles of the classical (atomic and electronic) structural theories. The boron hydrides have been represented as resonance hybrids involving structures with one-electron linkages. Longuet-Higgins and Bell², in a most interesting and important discussion, have given convincing evidence that the introduction of the unique and theoretically unlikely one electron linkage between two unequal atoms is unnecessary, and that the boron hydrides should be represented by the bridge formulæ of type



containing hydrogen bonds³.

Since hydrogen bonds are generally formed between atoms with unshared electrons and hydrogen atoms belonging to strongly polar linkages, whereas no unshared electrons are available at the B atom and the B—H linkage may be only slightly polar, Longuet-Higgins and Bell prefer to distinguish the linkages in the boron hydrides from other hydrogen bonds as resonance links. This implies a stabilization due to resonance involving no electron linkages. It is assumed that electrons belong to the orbitals of more than two atoms, that is, are non-localized



However, two factors should be essential for the formation of the electrostatic hydrogen bond: (1) presence of opposite charges at the two atoms, (2) the possibility of a sufficiently close approach of the atoms. Decreasing size of the atoms and absence of other atomic orbitals sterically inhibiting the approach of the second atom will facilitate the formation of a hydrogen bond. Such favourable conditions exist particularly in the case of small and unshielded atoms such as H, B, F, O, etc., the presence of unshared electrons is incidental. The charges at the B and H atoms in boron hydrides may be small, but this could easily be compensated by the presence of two linkages and the rather short B—H distances, which should not be longer than 1.6 Å.

It is not justifiable to assume that the H atom in BH₃ is unlikely to form a hydrogen bond of an essentially electrostatic nature with the B atom of another molecule, because this ability decreases rapidly in the series HF, H₂O, H₃N, H₄C. The charge at the H atom being positive will decrease in the former three molecules to become negligible, although possibly already negative in CH₄.⁴ Certainly in BH₃,

it should be negative* and again greater. Moreover, in contrast to the completely shielded C atom in CH₄, the B atom, like the F, O, and N atoms, will allow the approach of another H atom.

The formation of stable ring structures rather than of long-chain structures by hydrogen bonds will depend on steric influences, including the ability of the participating atoms to form sufficiently strong linkages at the angles required. Steric conditions being satisfied, ring structures of smallest polymerization degree will always be more stable because of the increased stability due to an additional hydrogen bond and an increased polarization of the linkages involved. Thus, carboxylic acids possess a dimer ring structure, *ortho*-nitrophenol and numerous similar substances form intramolecular rather than intermolecular hydrogen bonds.

The formation of an electrostatic linkage will, of course, not only depend on the size of the atoms essentially determining the interatomic distance, but also on the degree of their charges, which will increase in the series (+)B—H(−) < (+)Al—H(−) < (+)Ga—H(−) and compensate for the lengthening of the interatomic distance.

The interpretation of the unexpectedly complicated infra-red spectrum of diborane has offered considerable difficulty⁵. An analysis based on the suggested structure containing different covalent B—H and electrostatic B—H linkages should be of interest. However, a decision between these structures is only possible by a comparison of analyses based on both the 'symmetrical' and the 'unsymmetrical' bridge structure.

The stability of boron hydrides does not require the introduction of a new type of resonance involving no electron linkages.

A BURAWOY.

College of Technology,
Manchester
Dec 21

* During a discussion following a lecture by Mr R. P. Bell on November 30, Prof. J. Kenner independently directed attention to this point and emphasized its importance in relation to this problem.

¹ Burawoy, *Trans. Far Soc.*, **40**, 537 (1944), *Chem. and Ind.*, 434 (1944), cf. also Burawoy, *Trans. Far Soc.*, **39**, 79 (1943), *Chem. and Ind.*, 855 (1940), Samuel, *J. Chem. Phys.*, **12**, 167, 180, 380 (1944).

² Longuet-Higgins and Bell, *J. Chem. Soc.*, 250 (1943).

³ For original literature, see ref. 2.

⁴ Timm and Mecke, *Z. Phys.*, **98**, 363 (1935). Fuchs and Wolf, "Die elektrische Polarisation", *Hand- und Jahrbuch der Chem. Phys.*, 356 (Leipzig, 1935). Trieschmann, *Z. phys. Chem.*, **32B**, 22 (1936). Cf., however, Smyth, *J. Phys. Chem.*, **41**, 215 (1937).

⁵ Stitt, *J. Chem. Phys.*, **9**, 780 (1941).

THE chief contention put forward in our earlier paper was that in diborane and similar molecules there were pairs of hydrogen atoms which occupied a special position in linking together different parts of the molecule. We agree with Dr Burawoy that the formulation of these links as resonance hybrids represents only one way of describing this state of affairs: for example, a molecular orbital treatment of the system would not involve the use of the resonance concept. On the other hand, we doubt whether this linkage can be regarded as an electrostatic 'hydrogen bond' of the type met with in HF, H₂O and NH₃. The tendency to this type of dipole association decreases rapidly along the series FH, —QH, > NH, C≡H, and it would be remarkable if it appeared again to a high degree in >BH. It is, of course, conceivable that the BH link has a considerable dipole with the negative end on the hydro-

gen atom, but it is not likely that this would lead to the formation of a stable dimer showing no tendency to further polymerization. A much more likely result would be the formation of an indefinite series of polymers, as is the case with H_2O , HF and NH_3 . It is improbable that the small size of the boron atom is a determining factor, since the hydrogen compounds of aluminium and gallium dimerize as well as those of boron.

If B_2H_6 did contain electrostatic hydrogen bonds, the two central hydrogen atoms would not be equidistant from the two boron atoms. As Dr Burawoy suggests, information on this point might be obtained from the vibrational spectrum of diborane, though the differences in symmetry involved are not such as to produce markedly different selection rules for the symmetrical and unsymmetrical models. However, we have recently made detailed calculations of the normal vibrations of a B_2H_6 molecule containing

ing a symmetrical bridge $\begin{array}{c} \text{H} \\ \diagdown \quad \diagup \\ \text{B} \quad \text{B} \\ \diagup \quad \diagdown \\ \text{H} \end{array}$, and have

obtained excellent quantitative agreement with the observed infra-red and Raman spectra¹. This agreement makes it unlikely that the central hydrogen atoms are unsymmetrically placed.

R. P. BELL.

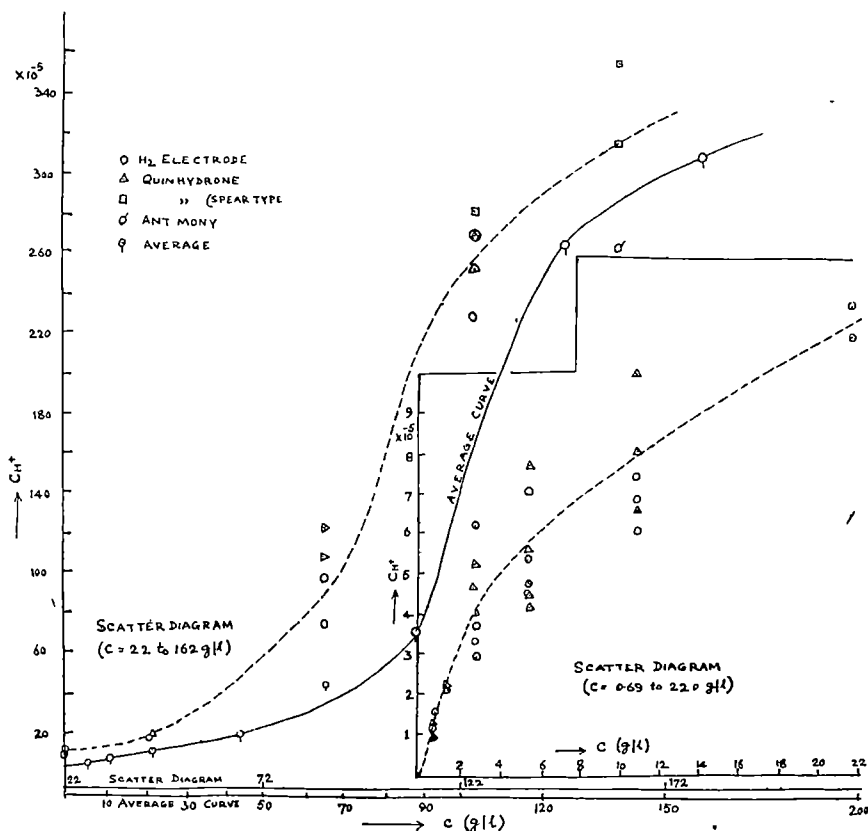
H. C. LONGUET-HIGGINS

Physical Chemistry Laboratory,
University, Oxford.

¹ Details will appear shortly in *Proc. Roy. Soc. A*.

Effect of Concentration on the Free and Titratable Acids of Hydrogen Bentonites Sols

HYDROSOLS of hydrogen clays and hydrogen bentonites show a marked acid character and give potentiometric and conductometric titration curves with bases having definite inflexion points and breaks^{1,2,3}. A linear relation between the H^+ -ion concentration C_{H^+} , and the concentration of the colloid, C , was observed by Wiegner and Pallmann⁴ in the case of dilute sols having concentrations up to about 0.3 per cent. At higher concentrations the slope, dC_{H^+}/dC , progressively decreased. Some interesting effects of the concentration of the colloid on the H^+ -ion concentration of the sol as well as



the amount of the acid calculated at the inflexion point of the potentiometric titration curve with sodium hydroxide have been observed in the case of a hydrogen bentonite, Kashmir-B, isolated from a deposit of bentonite in Kashmir. X-ray analysis showed that Kashmir-B did not probably contain any mineral other than montmorillonite⁵.

Hydrogen, quinhydrone and antimony electrodes were used for measuring the pH. A 'spear type' quinhydrone electrode prepared as described by Sanders⁶ was also used in the case of very concentrated sols and pastes.

Several determinations of the pH were made at each concentration. These are shown on the accompanying scatter diagrams drawn separately for two ranges of concentrations, 0.69–2.2 per cent and 2.2–16.2 per cent. The full curve shows the average C_{H^+} at the various concentrations.

C_{H^+} increases almost linearly with C until the latter attains a value of about 0.2 per cent. Beyond this point, and up to a concentration of about 2 per cent, the slope, $dC_{\text{H}^+}/dC (= \alpha)$, gradually diminishes. A sudden decrease in the cataphoretic velocity and a rapid fall of the equivalent conductivity were previously observed⁷ at a concentration of about 0.2 per cent of the same hydrogen bentonite sol.

The slope, α , increases at concentrations higher than 2 per cent, and a steep rise and an inflexion in the $C_{\text{H}^+} - C$ curve is observed at a concentration of about 10 per cent. Beyond this concentration the slope again decreases.

The progressive decrease in α at moderate concentrations possibly indicates a secondary adsorption of increasing numbers of mobile H^+ ions of the double layer⁸. The increase in the slope and the inflexion observed at higher concentrations are to be

attributed to a re-liberation or 'mobilization' of some of the secondarily adsorbed H^+ ions by strong fields of force which operate as the individual double layers overlap. The formation of some sort of a structure in the system is indicated. The viscosity of the sol has been found to increase rapidly with the concentration, and the system becomes thixotropic (the sol sets in about three hours) at approximately the same concentration at which the sharp rise in the H^+ ion concentration occurs.

The potentiometric titration curve of the sol with sodium hydroxide has a weak monobasic acid character and shows a marked inflexion at pH 8.5. The amount of the acid (T) neutralized at the inflexion point increases from 81.0 to 103.0 m.e. per 100 gm. of the oven-dried hydrogen bentonite as the concentration increases from 0.25 to 8.8 per cent. T increases with C at a much smaller rate than C_{H^+} , especially in the range of concentrations where the inflexion in the $C_{H^+} - C$ curve is observed. The increase in T with C is due to factors other than those responsible for the variations in the base-exchange capacity of hydrogen clays which have been observed when the sols are titrated with different bases, and in the presence and absence of salts^{9,10}. Assuming that aggregation or structure formation in the concentrated sols causes a decrease in the available surface, a decrease instead of an increase in T would be expected at the higher concentrations if the interaction with the base were confined to the outer surface of the particles.

This work has been carried out with the aid of a grant from the Imperial Council of Agricultural Research, India.

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¹ Mitra, *Ind. J. Agric. Sci.*, **6**, 555 (1936).

² Mukherjee, Mitra and Mukherjee, *Trans. Nat. Inst. Sci. Ind.*, **1**, No. 10, 227 (1937).

³ Mukherjee and Mitra, *Ind. J. Agric. Sci.*, **12**, 433 (1942).

⁴ Wiegner and Pallmann, *Ver. Zueri Komm. Alkali-subcomm. Internat. Bod. Ges.*, **B**, 92 (1929).

⁵ Unpublished work of S. N. Bagchi.

⁶ Sanders, *Ind. Eng. Chem., Anal. Ed.*, **10**, 274 (1938).

⁷ Mukherjee and Sen Gupta, *Nature*, **145**, 971 (1940).

⁸ Mukherjee, *Kolloid Z.*, **62**, 257 (1933).

⁹ Mitra, Mukherjee, S., and Bagchi, *Ind. J. Agric. Sci.*, **10**, 303 (1940).

¹⁰ Mukherjee, Mitra, Chatterjee and Mukherjee, *S., Ind. J. Agric. Sci.*, **12**, 86 (1942).

'Figure of Merit' of X-Ray Tubes

At the Leeds meeting of the X-Ray Analysis Group of the Institute of Physics¹ I gave certain figures for the comparative speeds of photographs using a Philips tube, a Shearer gas-tube and the 5 kW filament tube at the Davy Faraday Laboratory.

In justice to the commercial tube makers, I ought to make it clear, as I hoped I had made it clear at the meeting, that the Philips tube I had used for purposes of comparison (the only one available to me at the time) was already eleven years old and had, in fact, since 'died'. The Shearer tube was just as old, but demountable tubes never die, they only fade away, when it becomes desirable to replace them

by a more modern design. The tests I carried out were also made under particular conditions, that is, using a $\frac{1}{2}$ mm diameter cylindrical collimator and a rotating single crystal. I have since had the opportunity of repeating these and other tests using a more modern (just pre-war) Philips tube and other commercial tubes, and I find that, in the same exposure time, the Shearer tube still gives the most intense single-crystal photograph using copper K radiation, but the difference is smaller.

The gas-tube focus is (as used in projection, and under our running conditions) about 2 mm $\times$ 1 mm, and a $\frac{1}{2}$ mm cylindrical slit therefore wastes at least seven-eighths of the tube output in the required direction. If a still finer slit were to be used for crystals having large unit cells and therefore requiring high resolution of reflexions on the photographs, the wastage of output would be even greater, but for powder spectroscopy, for which a 2 mm $\times$ $\frac{1}{2}$ mm straight slit could be used, it would be much less.

I strongly agree with Sir Lawrence Bragg that manufacturers should give some 'figure of merit', which should indicate both focal spot size and comparative output of the various tubes now made. The principal advantages of the gas-tube are the purity of its radiation even after long running, the low input (about 400 watts) and the very low initial cost of the whole outfit, when an induction coil and electrolytic interrupter are used. These factors ought also, of course, to be considered in connexion with any standards of comparison that might be adopted. The cost is particularly important, because the price of apparatus is, unfortunately, a serious and sometimes crippling consideration with research workers in general.

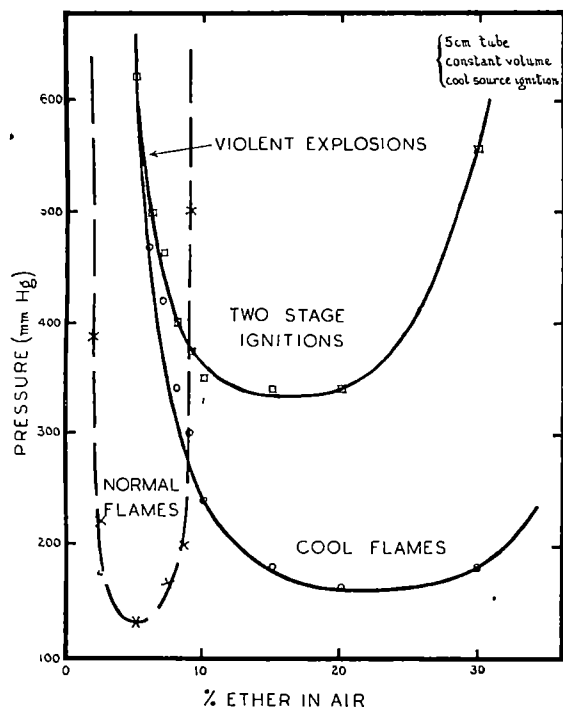
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¹ "X-Ray Equipment for Crystallography", *Nature*, **155**, 244 (1945).

The Cool-Flame and Two-Stage Ignition Systems in Ether-Air Mixtures at Room Temperature

The normal and cool-flame systems in diethyl ether-air etc. mixtures have been defined by means of diagrams showing the influence of pressure on their respective ranges of inflammability¹. Whereas the normal flame range centres upon approximately the theoretical mixture or that capable of developing the highest flame temperature and consequent flame speed, the cool-flame range appears to centre upon the mixture giving rise to the fastest reaction in slow combustion. High-tension sparks are employed for igniting the normal flames, but a suitably heated element must be used for the cool flames. If the experimental pressures in the cool-flame range be increased, pressure-composition limits may also be defined for the initiation of a second-stage 'blue' flame in the cool-flame products, this arises from the autogenous decomposition of peroxidic material formed in these products. This two-stage phenomenon is identical with that occurring in media *spontaneously* ignited at suitable temperatures and pressures², the essential difference being that with artificial ignition in cold media, the limiting pressures are much higher.



Hitherto it has not been possible with cold media to identify the cool-flame range within the normal flame range, for attempted ignition of cool flames by the means stated has invariably given rise to normal flames. An advance in this field has recently been made in that it is now possible completely to establish the cool-flame system (see graph), this was achieved in the first instance by allowing a cool flame initiated in a combustible-rich mixture located in one section of a 1.5 cm tube to pass into a mixture of composition within the normal flame range located in another section, connexion being effected by means of a uniform-bore tap. Similar observations have also been made with higher hydrocarbons and other suitable combustibles, and later the procedure became simplified when it was found possible successfully to employ a specially designed igniting source at rigidly controlled temperature. The importance of these observations may be appreciated by the statement that under suitable pressure conditions it is possible for a cool flame to travel quiescently through even a *theoretical* combustible air-oxygen mixture which, if subjected to a spark or other usual igniting source, would give rise to an explosion shattering the containing vessel. At higher pressures (Fig 1) the two-stage ignition mechanism occurs, giving rise in such a mixture to an explosion of great violence and of the type enhanced by shock waves. Indeed, there is strong evidence that under the conditions arising in internal combustion engines this two-stage ignition mechanism is, in fact, that responsible for 'knock'.

These observations throw light on the kinetics of the processes concerned, they may also be of significance when considering possible sources of ignition of inflammable vapour-air media in industries where solvents are employed, or possibly in operating theatres in hospitals. For it is possible for a cool flame initiated by a low-temperature source in a rich mixture (for example, ether vapour near a floor) to pass unobserved for some distance until, on pass-

ing into a mixture of higher oxygen content (for example, ether vapour more remote from a floor), an explosion of violence might occur.

The investigations referred to form part of a larger programme assisted by the Department of Scientific and Industrial Research.

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Jan 23

¹ White, *J. Chem. Soc.*, 1462 (1919), 498 (1927). Townend and Chamberlain, *Proc. Roy. Soc. A*, 158, 415 (1936). Hsieh and Townend, *J. Chem. Soc.*, 337 and 341 (1939). Macormac and Townend, *J. Chem. Soc.*, 143 and 151 (1940).

² For example, Townend, *Chem. Rev.*, 21, 259 (1937).

Particle Shape

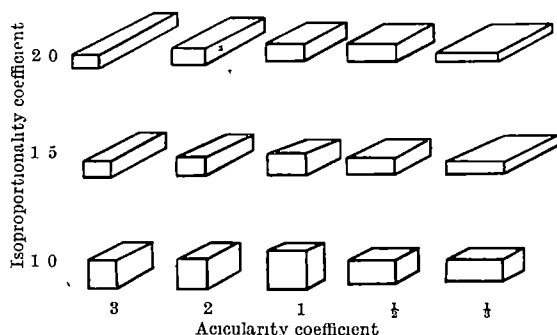
In the chemical literature it is customary for crystalline substances to be characterized as forming needles or plates. It is interesting to note that this concept of acicularity can be given a precise quantitative meaning and applied to any regular solid figure of which the three principal dimensions are known, and may be extended to cover the general form of irregular figures. In the present instance, rectangular solids are considered for the sake of simplicity, and the three dimensions denoted as a , b , c , where $a \geq b \geq c$.

Psychological tests have shown that a figure is instinctively considered to be acicular if a is greater than b or c , and tabular if a is less than b or c . If a equals b or c , no decision can be obtained as to whether the body is to be considered acicular or tabular. This criterion, related as it is to ordinary experience, is therefore considered to be the most satisfactory to adopt, and we define a quantity called the 'acicularity coefficient' as

$$\text{acicularity coefficient} = \frac{a}{b} - \frac{b}{c}$$

Bodies thus have an acicularity coefficient greater than unity if needle-shaped, and less than unity if tabular.

In the accompanying diagram the acicularity coefficient is constant in any vertical column. Another parameter is therefore required in order to specify uniquely any given shape. This is provided by a/b or b/c , whichever is the smaller. For this parameter we propose the name of 'isoproportionality coefficient', as it specifies the figure in the central column of the diagram which may be considered to be the parent figure of the corresponding horizontal row, just as the cube is the parent figure of the square prisms.



The correct method of applying these concepts statistically to a collection of particles is indicated as follows. If the particles have no inherent tendency to a needle- or plate-like form, it follows that those with an acicularity coefficient of n and $1/n$ will occur with the same frequency, and hence, for any one value of the isoproportionality coefficient, the sum of the values of $a \cdot b$, and the sum of the values of $b \cdot c$ will be equal, that is

$$\overline{a \cdot b} - \overline{b \cdot c} = 1.$$

Any inherent tendency to needle- or plate-like form will modify this value accordingly, and we therefore define a quantity, the acicularity factor, as

$$\text{acicularity factor} = \overline{a \cdot b} - \overline{b \cdot c},$$

which is equal to the acicularity coefficient of a mean particle averaged in the special way involved in this definition. This derivation is applicable severally to groups of particles having every possible value of the isoproportionality coefficient, and therefore is applicable to any group of particles whatever, providing it be sufficiently large.

For statistical use, the isoproportionality coefficient will similarly give place to the isoproportionality factor, defined as

$$\text{isoproportionality factor} = \overline{x \cdot y},$$

where $x \cdot y$ is the smaller of the two ratios $a : b, b : c$, for each individual particle.

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Boron and Strontium in New Zealand Coal Ashes

ATTENTION has been directed by V M Goldschmidt¹ to the occurrence of minor elements in coal ashes. During the complete analysis of ash of Waikato coal examined in connexion with clinkering troubles, Mr F. T. Seelye, chief chemist at the Dominion Laboratory, New Zealand, noted a high boron content. The Coal Survey Division then undertook an examination to determine the distribution of boron in New Zealand coal ashes. Boron was present in highest amount in Waikato coals, but was also present in smaller percentages in all New Zealand coals.

The accompanying table sets out the maximum and average percentages of boron in each coalfield. The factor of enrichment of boron in coal ashes has been worked out as in Goldschmidt's paper, by comparing the percentage of boron in coal ash with the percentage of boron in the earth's crust taken as 0.0003.

Another element occurring in unusual amounts is strontium. Strontium has been determined by a spectrographic method similar to that described by Wilson and Fieldes², but modified by them to permit the determination of strontium directly on the ash, without separation of lime and strontia (unpublished method).

Strontium was found to be much higher than is usual in rocks, amounting to 0.3 per cent strontium

Coalfield	Class of coal	Maximum % boron	Average % boron	Factors of enrichment Maxi- Aver- mum age	
North					
Auckland	Sub-bituminous	0.21	0.21	700	700
Waikato	"	1.51	1.09	5,000	3,000
Taranaki	"	0.73	0.58	2,400	1,900
Westport	Bituminous	0.29	0.29	1,000	1,000
Reefton	Sub-bituminous	0.86	0.86	3,000	3,000
Greymouth	Bituminous	0.15	0.07	500	250
Otago	Lignite	0.14	0.11	500	400
Kaitangata	Sub-bituminous	0.44	0.39	1,500	1,300
Southland	"	0.24	0.18	800	600
Chatham Islands	Peat	0.10	0.10	300	300
Goldschmidt's figure for coalashes rich in boron		0.30	0.06	1,000	200

oxide in several Waikato coal ashes. In ash from Mangapehi, an area south of the Waikato coalfield, the strontium content was found to be far above the amount usually determined spectrographically. A chemical determination revealed 1.3 per cent strontium oxide. The percentage was then confirmed by modifying the spectrographic method.

Further information is necessary before any conclusion as to the reason for these high concentrations can be put forward. It is significant that boron and strontium are relatively high in sea-water, and the high content of both may be connected in some way with contact of the coal measures with the sea. It must also be noted that the coals high in these constituents occur in hot spring or volcanic areas.

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¹ Goldschmidt, V. M., *J. Chem. Soc.*, 655 (1937).

² Wilson, S. H., and Fieldes, M., *N.Z. J. Sci. and Tech.*, 24, 98 (1942).

Red Shift in the Anagalactic Nebulae

A PHOTON $h\nu$ emitted by a distant nebula toward our galaxy possesses a mass

$$\mu = \frac{h\nu}{c^2} \quad \dots \quad (1)$$

and the equation for its energy is

$$h\nu = \mu c^2 \quad \dots \quad (2)$$

The mass μ of the photon is acted upon by the gravitational field of our galaxy, whatever this field may be. Newtonian, LeSagien¹, or the relativistic curvature of space caused by the mass of the galaxy.

The law of gravitation requires that any mass in the field of our galaxy must be accelerated toward it. Therefore, using the inverse square law for falling bodies, the energy of the photon from the nebula we observe should be

$$h\nu = \mu \left[\sqrt{c^2 + k \left(1 - \frac{R}{A}\right)} \right]^2 = \mu \left[c^2 + k \left(1 - \frac{R}{A}\right) \right], \quad (3)$$

where $k = \frac{2GM}{R}$, R is radius of our galaxy (assuming

it to be spherical as a first approximation), A is the distance from the galaxy to the nebula, M is mass of our galaxy, and G is the gravitational constant. However, according to the principle of relativity, no mass can acquire a velocity greater than c , the velocity of light *in vacuo*. Consequently, in order to preserve the law of gravitation, together with the conservation of energy involved, and to agree with the principle of relativity the following equation must be satisfied

$$h\nu - \mu k \left(1 - \frac{R}{A}\right) = \mu c^2, \quad (4)$$

or, substituting μ by its value from (1), we have

$$h\nu \left[1 - \frac{k}{c^2} \left(1 - \frac{R}{A}\right)\right] = \mu c^2. \quad (5)$$

On the right-hand side of this equation c is constant and, therefore, μ cannot vary, which makes μc^2 constant. On the left-hand side of the equation, h is Planck's constant. Therefore, in order to satisfy equation (2), ν which we observe in the photon coming from the nebula, and which is on the left-hand side of equation (2), must have a value different from ν which the photon possessed at the moment of emission, and become a variable frequency ν^1 , a function of the argument A . Equating (2) with (5), we have

$$h\nu^1 = h\nu \left[1 - \frac{k}{c^2} \left(1 - \frac{R}{A}\right)\right]. \quad (6)$$

This equation shows that under an acceleration by the field of gravitation a photon keeps its velocity constant by adjusting its frequency so as to compensate for the variation due to the acceleration.

The red shift of the 'expanding universe' is an immediate corollary of equation (6), as the observed wave-length λ^1 is $1/\nu^1$, and, therefore, increases with the distance A .

It seems that the idea presented is worth discussion, I should be much interested in any comments on the subject.

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¹ Abbott, C G, "The Newtonian Lucretius", *Smithsonian Misc Collections*, 142 (1899). Shneiderov, A J, "The Exponential Law of Gravitation and Its Effects on Seismological and Tectonic Phenomena", *Trans Amer Geoph Union*, 61 (1943).

Surface Tension of Solutions

In a recent paper¹, Wales discusses the approximate relations for the surface tension of regular solutions. He concludes that the surface tension is linearly or quadratically related for ideal and regular solutions respectively to the molar volume fractions of the components.

Two facts, however, limit the applicability of these relations: (1) The omission to take into account the adsorption at the surface which is responsible for the disagreement between the relations obtained and the Gibbs equation for the surface tension. (2) The neglect of the orientation of molecules at the surface.

In a theory I have recently developed² both those effects are accounted for in terms of the monolayer, while the derived relations for the surface tension agree perfectly with the Gibbs equation and cover the whole range of concentrations. At close values of the surface tension, relations analogous to those derived by Wells are obtained, while the surface tension for ideal solutions is linearly related to the surface molar fraction, which indicates the area occupied by molecules of the given species in the monolayer. An inspection of the benzene-carbon disulphide system, discussed by Wells, shows the carbon disulphide molecule to be oriented perpendicular to the surface.

A paper devoted to the statistical treatment of regular solutions and, in particular, to the analysis of the benzene-carbon disulphide system was ready in February 1944 and is to appear shortly in *Acta Physicochimica USSR*.

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¹ *J Chem Phys*, 12, 134 (1944).

² *Acta Physicochim USSR*, 19, 176 (1944).

Plant-Growth Substances and *Penicillium notatum*

It was considered of interest to study the effect of plant-growth substances on the production of penicillin by the mould *P. notatum*. Several experiments have been carried out using indole-3-acetic acid and α -naphthalene acetic acid. The study has included the use of various media with the Squibb strain of *P. notatum* (American Type Culture Collection). Heavy spore inocula were added to two quart bottles (flat type) containing about 300 ml. of the medium. The bottles after inoculation were kept at 23-24°C and 80 per cent humidity. As might be expected, marked stimulatory effects of the growth-substances were found only in the cases of the simple media, such as Czapek-Dox with added brown sugar. The experiments reported refer to penicillin production in the latter medium with 4 per cent brown sugar. Addition of either of these growth-substances at the concentration of 1 part in 30,000 had no effect in a mineral and corn-steep (6 per cent) medium. The titres obtained with the simple medium plus the growth substances are higher than have previously been reported for this medium alone. The practical value of the findings is limited, however, for much higher titres are the rule with the corn-steep media. This work suggests that a part of the good results got with the corn-steep may be ascribed to its containing plant-growth stimulants; but this point has not been checked.

The results of repeated tests have been somewhat erratic because of the variation in bottles inoculated under identical conditions. Almost without exception, however, the bottles containing the growth substances have developed mature mould mats in somewhat shorter times, and the titres of penicillin (both at the same time and at comparable stages during the development of the mat) have been higher than in controls. It is not known whether this is due to a faster growth or to a greater total growth of the mould, or to an increased secretion of penicillin. It is thought that faster growth of the mat will account for the findings, for, of course, the quicker the peak concentration of penicillin is reached, the higher it will be, there being less time for the decomposition of the accumulating penicillin.

A single, complete experiment is given in the table, the titres representing the best bottle of a triplicate group. Repeated experiments gave the same indications, but not usually the same figures.

EFFECT OF PLANT-GROWTH SUBSTANCES ON PENICILLIN TITRES FROM *P. notatum* ON A SIMPLE MEDIUM

Medium	Days after inoculation	Penicillin (Florey units per ml)
Control	6	30
Indole acetic acid, 1 in 10,000	6	50
Naphthalene acetic acid, 1 in 10,000	6	25
Control	7	35
Indole acetic acid, 1 in 10,000	7	50
" 1 in 100,000	7	35
Naphthalene acetic acid, 1 in 10,000	7	40
" 1 in 100,000	7	50
Control	11	28
Indole acetic acid, 1 in 10,000	11	50
" 1 in 100,000	11	30
Naphthalene acetic acid, 1 in 10,000	11	30
" 1 in 100,000	11	45

It is thus seen that indole acetic acid at a concentration of 1 part in 10,000 gives the quickest high titre of penicillin, whereas it is not so active at 1 to 100,000. Naphthalene acetic acid is more active at 1 part in 100,000, giving a titre peak in seven days. The two concentrations mentioned were the only ones studied, and it is likely that the optimal one has not been chosen. Work along these lines is being continued.

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Ripening of the Onion Bulb and Infection by *Botrytis* Species

THE first sign of normal ripening in the onion plant, it is supposed, consists of a local collapse at the neck, resulting in the leaf blades falling over on to the ground while several of them are still green and turgid, this can occur with plentiful soil moisture^{1,2}, though hastened by drought, and has been attributed (*loc cit*) to a softening of the tissues of the neck. The true explanation would appear, however, to be purely mechanical, and connected with the mode of development of the onion bulb. In the absence of bulbing, as in an onion plant growing in short days, new leaves emerge at regular intervals. Each leaf consists of a thin-walled hollow cylindrical leaf base surmounted by a more or less cylindrical 'blade' which is at first solid but later develops a lysigenous cavity. At the junction of the leaf base with the leaf blade a pore is found, through which the next younger leaf emerges. The neck of the actively growing onion plant thus consists of a number of very thin concentric leaf bases enclosing a practically solid core of growing leaf blades. The outermost leaf bases are dead and papery, but even the living ones have little inherent rigidity, the solid core is formed by the blade or blades of the one or two leaves next emerging. When, under the stimulus of long days, bulb development occurs, leaf emergence ceases immediately or soon according

to conditions^{2,3} and the three leaf initials next due for emergence become instead swollen bulb scales with practically no leaf blade³. The result is that after the blade of the last leaf has emerged there are no more to provide the solid core of the neck, which thus becomes a thin-walled hollow tube. This soon buckles and collapses under the weight of the green leaf blades, especially in wind or drought. Experiment has shown that removal of the central core very greatly reduces the resistance of the neck to buckling.

The common horticultural practice of bending onion plants over at the neck to hasten ripening thus appears groundless. If bulbing has not proceeded far enough to stop leaf emergence, the practice can only result in breaking or bruising the next emerging leaf blade, while if leaf emergence has ceased the neck will of itself collapse very soon, though there seems no obvious reason why this should either hasten the drying of the leaf blades or the onset of dormancy, which together accompany ripening.

Before bulbing occurs, the pore at the junction of leaf base and blade is from the earliest developmental stages of the leaf initial blocked by the tip of the subsequent leaf³. The last leaf to emerge after bulb development, however, has an open pore, since the next leaf initial forms a swollen bulb scale the blade of which fails to elongate. If, therefore, this last leaf emerges fully before collapse of the neck occurs, the onion plant has then a more or less open pore communicating directly by the hollow neck with the interior of the bulb. Since we have in a number of cases found the swollen bulb scales infected (apparently with *Botrytis* spp.) while the surrounding swollen leaf bases³ have appeared healthy, it would seem that this probably provides one of the modes of infection of the onion bulb by spores of *Botrytis* spp., which constitutes one of the main problems of economic importance connected with onion culture and storage in Great Britain. Another likely path of infection is via the pores of the other (older) leaves, since these sag open as the leaves wither and thus provide pockets for the lodgment of air-borne spores and probably fairly high humidities for their germination. This would presumably lead in the first instance to infection of the swollen leaf bases rather than of the swollen bulb scales, and this is the most frequently observed condition in the early stages of *Botrytis* 'neck rot'. That infection does in fact occur via these pores is indicated by our observations of the occurrence of 'neck rot' in the greenhouse, where the plants are somewhat etiolated and the necks very much longer than under field conditions. Here the tissues of the leaf bases are killed high up on the neck near the pores, and even the whole neck rotted through at that level, before the bulb shows any obvious infection.

The above considerations provide yet another example of the importance of the cessation of leaf emergence with bulb development in accounting for the behaviour of the onion plant².

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¹ Heath, O V S, *Ann Appl Biol*, 30, 208 (1943)

² Heath, O V S, *Ann Appl Biol*, 30, 303 (1943)

³ Heath, O V S, and Mathur, P B, *Ann Appl Biol*, 31, 173 (1944)

Sulphonamides and American Foul Brood Disease of Bees

AN editorial note in a recent issue of *Gleanings in Bee Culture* (72, 493; 1944) reports on the use of sulphathiazole in the treatment of American foul brood disease of bees by Prof. Haseman, University of Missouri, Columbia. Sugar syrup containing sulphathiazole fed to the bees enabled them to raise healthy brood in combs containing the scales of larvæ which had died of the disease.

In 1943, Mr. C. A. Ekins, of Brookwood Hospital, Surrey, sent to this Department an account of some experiments he had been carrying out since May of that year, in which sulphapyridine was being used in the treatment of five colonies of bees affected with American foul brood. He continued his experiments until July 1943 (with further treatment as a preventative measure in the following spring), since which date, he reports, there has been no recurrence of the disease. No evidence of disease was found when the colonies were examined in May 1944 by the local officer appointed for the inspection of apiaries under the Foul Brood Disease of Bees Order.

Following upon Mr. Ekins' claims of complete success with his treatment, and after consultation with him, it was decided to carry out a trial of sulphapyridine in the experimental disease apiary at Rothamsted. Accordingly, in June 1944, two colonies of bees of approximately equal strength, and headed by hybrid queens of the same age, were infected with American foul brood by feeding them a suspension of the spores of *Bacillus larvæ* in sugar syrup. The disease was allowed to run its course in both colonies until August 3, when one of them was fed 600 ml. of sugar syrup containing 3 gm. of soluble sulphapyridine. This treatment was repeated at weekly intervals, four doses being given in all. The other colony was fed plain syrup in equal quantities on the same dates. On September 8 the bees in both colonies were killed and the combs then examined. No major honey flow occurred during the period of treatment.

There was a marked difference between the two sets of combs. In those from the treated colony all the recent brood appeared healthy, though somewhat scattered and irregular in arrangement. No larvæ in the early or ropy stage of the disease were found, with the exception of two individuals situated on a comb remote from the three combs forming the actual brood-nest. Scales, the formation of which normally takes about three weeks from the death of the larva, were, however, present in eight out of the eleven combs in the hive. In the combs from the untreated colony many ropy larvæ were present, along with others showing the progressive stages leading to the formation of the scale.

It would appear, therefore, that during the course of the treatment the progress of the disease within the colony had been arrested, and that only healthy brood was being reared in combs where the disease had previously been established. The test was a severe one owing to the length of time which elapsed between infection and the beginning of the treatment; it was purposely not carried to its ultimate conclusion because of the lateness of the season and because of the danger of robbing by bees from other hives nearby.

It should be noted that the conditions of the experiment were not identical with those of the ex-

periments carried out by Mr. Ekins, who combined manipulative methods with the sulphapyridine treatment, and a complete elimination of the disease, as claimed by Mr. Ekins with his methods, was not obtained. The result does, however, justify the planning of future tests on a larger scale.

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Phagocytosis and Storage of Trypan Blue in the Appendix of the Rabbit

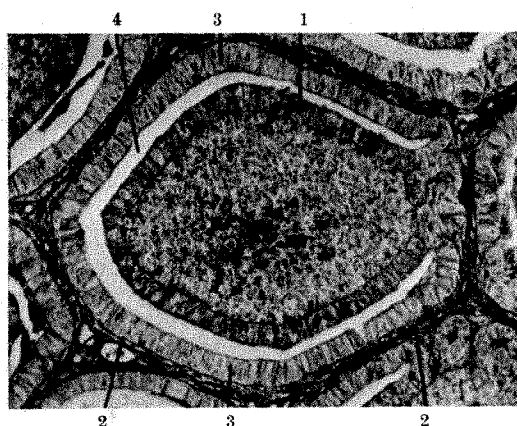
THE observations of Baker and Enticknap¹ substantiate the claim of Bizzozero and Ruffer (cited by McEwan²) that an active phagocytosis occurs in the appendix of the rabbit, the agents concerned being large mononuclear cells present in the lymph follicles and lymph papillæ of the submucosa. The following observations, made on the appendices of vitally stained adult rabbits throw additional light on this process.

The dye, trypan blue, was administered subcutaneously in a 2 per cent solution in distilled water and the animals were killed at various intervals after stopping the injection. The amounts of the dye used, the frequency of the injections and the times when the animals were killed are given in the accompanying table.

Rabbit	Daily dose of trypan blue (c.c.)	No. of injections	Time between last injection and killing
1	2.5	1	12 hr.
2	2.5	2	2 days
3	2.5	2	10 days
4	5.0	2	2 days
5	5.0	2	10 days
6	7.0	2	2 days
7	7.0	2	5 days
8	10.0	2	2 days
9	10.0	2	10 days

Following the administration of trypan blue in moderate concentration (R 1, R 2 and R 3) particular segregation of dye particles occurred in the cytoplasm of cells in the serous coat, in reticulum cells surrounding the follicles and in certain cells of the mucosa. The dye-containing cells in the serosal coat were frankly macrophagic. Those in the peri-follicular tissue were rather smaller, but the majority of them exhibited the staining characters of macrophages. A few showed an early rosette arrangement of the dye particles often seen in monocytes. These cells were abundant in the region of the peripheral lymph sinus of the follicles, and at many sites appeared to project into its lumen. Cells of similar size and with identical staining characters occurred near the lymph channels in the mucosa. At other situations in this zone, notably around encysted sporozoa (abundant in larger or smaller groups), macrophages with a more bulky cytoplasm were electively stained, and the appearances suggested that many of them play an important part in the defence reaction of the mucosal tissues towards these parasites. The follicular lymphocytes were not affected by the dye; but numerous large moribund cells and disintegrating cell debris in the centre, and to a less extent at the periphery of the follicles, were diffusely stained (see photo.).

The administration of the dye in larger amounts (R 4, R 5, R 6 and R 7) produced a marked increase in the number of dye-containing cells in the peri-follicular zone and around the mucosal lymph



LONGITUDINAL SECTION OF RABBIT APPENDIX (R.5) SHOWING DIFFUSELY STAINED MORIBUND CELLS IN THE CENTRAL AND PERIPHERAL REGIONS OF A LYMPH PAPILLA. MASSON'S PONCEAU-ACID FUCHSIN, $\times 120$.

1, Epithelium of papilla; 2, reticulum in deeper part of mucosa containing lymph channels and blood vessels; 3, mucosal lining; 4, lumen of appendix.

channels. In R 5 and R 7, the animals of this series which were killed at later periods, there was, as compared with R 4 and R 6, an appreciable reduction in the number of the stained cells associated with the lymph channels in the perifollicular and mucosal regions. This reduction appeared to be due to a desquamation or migration of the cells into the lymph follicles, where the appearances indicated that some were phagocytosed among the central cells of this region. R 5 and R 7 also exhibited fine dye inclusions in the cytoplasmic processes of the perifollicular reticulum fibres, and in many situations dye particles were observed in elongated cells lying adjacent to the endothelium of the blood vessels. In all animals of this series the intensity of the stained elements around encysted sporozoa deepened.

In more intensely stained animals (R 8 and R 9), cells of macrophagic character containing fine dye particles appeared in increasing numbers within the lymph follicles. Many of these cells had presumably migrated into this situation from extrafollicular sites, but there was evidence in R 9 that dye particles had been segregated by certain follicular cells—possibly lymphocytes which had developed in a macrophagic direction as a defence reaction to the increased stimulation.

It was noted that the central parts of most of the lymph follicles contained many large mononuclear cells having all the morphological characters of macrophages but which were entirely unaffected by the dye. These cells are probably identical with the phagocytic elements (macrophages) recorded by Baker and Enticknap¹. It may be that the relatively poor blood supply to the regions containing these cells accounts in part for their inability to segregate dye particles. On the other hand, it is possible that other activities peculiar to their situation, for example, phagocytic, incapacitate them from taking up other substances presented to them, as Cappell² has suggested in the case of similar cells found in lymph glands.

The above observations confirm the presence of numerous phagocytic cells within the lymph follicles of the rabbit appendix, but the majority of these are not readily stainable by means of trypan blue administered by the subcutaneous route. A renewal of

the elements concerned in this process from follicular cells is indicated, and the proximity of diffusely stained moribund cells and of extracellular dye particles to the epithelium covering the lymph papilla suggests a process of elimination at this site. It would appear that phagocytosis occurs mainly within the follicles. In this situation a true germinal or lymphoblastic core is not well established, and Crabb and Kelsal³, following the suggestion of Ehrlich⁴, refer to this tissue as "lymphoid" rather than lymphatic. Latta⁵ and West⁶ regard the central part of the follicle as a region of cellular degeneration rather than one of proliferation. Latta⁵ recorded a decrease in the number of lymphocytes and the presence of numerous moribund cells in the central parts of the follicles, and stated that this results from a local inanition due to the poor blood supply of these regions. Crabb and Kelsal³ observed "clusters of moribund large lymphocytes resembling the 'ghost cells' of Todd and Sanford"⁷ towards the periphery as well as in the central parts of the follicles, and recognized the possibility of the former site as being closely related to elimination.

While the levels of vital staining employed in the above experiments produced no obvious general upset in the animals, it is important that care should be exercised in the interpretation of results, for in this, as in other situations, the dye itself is obviously capable of producing proliferative changes in susceptible elements.

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¹ Baker, F., and Enticknap, J., *Nature*, **151**, 532 (1943).

² McEwan, R., *Brit. Med. J.*, **ii**, 873 (Oct. 1904).

³ Cappell, D. F., *J. Path. and Bact.*, **32**, 595 (1929).

⁴ Crabb, E. D., and Kelsal, M. A., *J. Morph.*, **67**, 351 (1940).

⁵ Ehrlich, W., *Amer. J. Anat.*, **43**, 347 (1929).

⁶ Latta, J. S., *Amer. J. Anat.*, **29**, 159 (1921).

⁷ West, L. S., *Anat. Rec.*, **28**, 349 (1924).

⁸ Todd, J. C., and Sanford, A. H., "Clinical Diagnosis by Laboratory Methods" (Philadelphia: W. B. Saunders Co.).

Colour-blindness in Left Eye following an Accident

A MAN of fifty years of age, knocked down by a bus in 1942, sustained fractures of facial bones on the left side, was unconscious for ten days, saw double for six months, had electrical treatment and recovered. There were no brain injuries, but severe facial paralysis on the left side. In 1944 he was brought by a friend, Mr. W. Macaulay, and proved an accurate and consistent observer. The left eye was his better eye before the accident.

Prof. Arnold Lowenstein kindly examined his eyes, with the following results: R. fissure 12 mm., L. 10 mm.; L. eyelids unable to close completely; no disturbance of eye-movements; L. cornea hypoesensitive; R. pupil 4 mm., L. 3.5 mm., both pupils gave immediate reaction to light, but L. reaction inconsiderable; convergence reaction to 2.5 mm. in both pupils. R. eye: fundus myopicus with inferior conus and optic colaboma between 5 and 7 o'clock; disk of pinkish colour. L. eye: 1-1.5 d. myopia; disk sharply defined, of a bluish-white colour; vessels well filled and no sheathing; atrophic excavation, small area of pigmentation round disk; otherwise fundus normal.

Usual colour names		Violet	Blue	Blue-green	Green	Yellow-green	Yellow	Orange	Red
Names used by subject	R eye	Light blue	Blue	Blue-green	Green	Yellow	Yellow	R yellow	Red
	L eye	Grey	Grey		Green		Grey	Grey	Grey

Visual acuity was corrected as follows, without correcting astigmatism R eye to 4/36 with -4.0 d, L eye to 4/18 with -1.0 d. With these corrections he did the Ishihara test (25 plates) R eye, all correct, L eye, none legible whatever.

Perimeter test R eye normal with 1 cm disks of red, yellow, green and blue L eye normal with 5 cm disks of red, yellow and blue, but 1 cm disk of green sufficed. No central scotoma, but red was less saturated in central area, L eye.

Independently of Prof Lowenstein, a colorimeter test showed that the right eye was normal but had a slight weakness in red, but the left eye was normal only for green, since red, yellow and blue were equated with greys of normally equivalent brightness.

After six to seven weeks, when the other tests were done, the right eye gave the same result, but the left eye had improved to about 1/25 normal thresholds for red, yellow and blue. This corresponded to the perimeter test, in which the left eye had 1/25 normal sensitivity to these colours.

The Edridge-Green Beads and the Holmgren Wools confirmed that colour vision was normal with the right eye, while green was the only colour seen clearly with the left eye. The colour perception spectrometer gave the result shown in the accompanying table.

The subject knew that he could see only green clearly with the left eye, and identified it as the colour he called green with the right eye.

The bearing of this case on theories of colour vision is important. It would be expected that primary colours, on any theory, might be lost independently of each other through shock or injury, and/or that colours lower in the scale of evolution, on any theory, would be retained longer after injury or shock, while those more recently evolved would recover last.

*Willmer's 2-colour theory*¹ Red and violet are the only primaries. Loss of these would give total blindness, partial loss would give darkening of both ends of spectrum and proportional loss of green. The theory is not supported.

Young-Helmholtz 3-colour theory Green might be retained while red and violet-blue were lost, but both ends of spectrum would be extremely darkened.

*Walls's modified 3-colour theory*². Weakness of colour vision is due to shifting of sensitivity curves so that they overlap. Red and blue-violet might be lost, but both ends of spectrum would be darkened, and, since all three sensitivity curves would now overlap in the middle, 'green' would be greatly brightened and would be wholly replaced by grey. No support is given to either form of the Helmholtz theory.

Ladd-Franklin's evolutionary theory If yellow and blue are lost, then both red and green must be lost, too, since they evolved later and depend on the integrity of the blue and yellow sensations.

Edridge-Green's theory. The dichromatic form of colour vision discriminates the ends of the spectrum as yellow and blue, and evolves out of monochromatic vision, in which only grey is seen. It develops into trichromatic colour vision, in which green is added between yellow and blue. In the case reported green

is distinguished from the ends of the spectrum, which are both grey, and it lends no support to the theory.

Hering's 4-colour theory Blue and yellow, and/or red and green, could be lost while the corresponding brightness sensations remained. Green could be retained, as in the case reported, while red, yellow and blue were lost, if the dissimilative process of the red-green pair became checked at the neutral point and could not proceed towards red.

*Houstoun's modification of Hering's theory*³ The changes from red to green and from yellow to blue depend on the proportions of red to green and of yellow to blue responses. Yellow and blue light might both excite yellow and blue responses equally frequently, giving yellow-blue blindness. Green light might still excite the normal preponderance of green over red responses, and red light excite both red and green responses equally often, so that the normal change over failed to proceed further than the neutral point. This would explain the case described.

In general, it may be concluded that the case described strongly negates all colour theories except Hering's, while Houstoun's modification of this theory is the most fully supported.

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¹ *Nature*, 151, 213, 632 (1943), 152, 190 (1943)

² Walls, G. L., "The Vertebrate Eye", 88ff (1942)

³ Houstoun, R. A., "Vision and Colour Vision", ch. 14 (1932)

Cannibalism in *Aurelia*

PLANULÆ of *Aurelia* were washed out of the brooding pits of the mother medusa and allowed to settle down in small dishes about 35 mm wide and about 7 mm high (very suitable for microscopic investigation). These dishes were gently placed in large basins (capacity about two litres) and left undisturbed until the larvæ got hold of their substratum. This usually took about 36 hours, after which time the basins were placed under running sea water, thus giving the larvæ access to their natural food. However, it was observed that certain scyphistomæ attacked their neighbours. The 'aggressor' would extend its body until the mouth would reach the 'victim', then the mouth would be widened so as to enclose the greater part of the victim, which would resist and stick firmly to the substratum. A struggle would take place, but at last the whole body of the victim would be taken in the coelenteron of the aggressor. The scyphistomæ usually bud off a number of individuals which separate and settle down round the mother-scyphistomæ, but cannibalism has not been observed among members of such a group.

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RESEARCH ITEMS

Secondary Sexual Characters in Beetles

THE great development of horn-like outgrowths in male Dynastid beetles is a conspicuous secondary sexual character. What these horns are used for has long attracted attention and excited speculation. William Beebe (*Zoologica*, 29, Aug. 1944) records observations made in the New York Zoological Society's Laboratory at Caripito, Venezuela, on the elephant beetles *Megasoma elephas* and *Strategus aloeus*. In both these species he finds that the males use their cephalic and thoracic horns for fighting with each other. The initial stimulus appears to be the advent of the rainy season. The technique of fighting seems to be the same for both species: first an effort to unbalance the opponent by tripping, and then by ventral attack with the anterior horn so as to throw him on his back. It is interesting to note that Charles Darwin, in the first edition of "The Descent of Man", claimed that the most obvious conjecture is that these horns are used by the males for fighting together. But since they had never been observed to fight, he came to the conclusion that they were acquired as ornaments. Eight years afterwards, A. R. Wallace, in "Tropical Nature", expressed the view that these horns may be protective. Their presence, he says, would render it very difficult for the large-mouthed goatsuckers and other nocturnal birds to swallow the beetles. It is therefore noteworthy that Mr. Beebe's observations appear to settle this disputed point, and are supported by a very convincing series of successive photographs taken of actual combats.

Intracellular Symbiosis and Vitamin Requirements of Insects

MANY insects contain symbiotic micro-organisms, usually bacteria or yeasts. The organisms are intracellular and are housed in special organs called mycetoms. One function of such organisms seems to be the synthesis of certain vitamins normally required for the nutrition of the insect. M. Blewett and G. Fraenkel (*Proc. Roy. Soc. B*, 132, 212, 1944) have studied this question in the case of the larvæ of two beetles, *Lasioderma serricorne* and *Sitotroga panicea*. It is possible to sterilize the eggs before hatching and so obtain larvæ free from symbionts (sterile larvæ). Such sterile larvæ fail to grow if the diet is deficient in any one of the following components of the vitamin B complex: thiamin, riboflavin, nicotinic acid, pyridoxin, pantothenic acid. On a diet rich in vitamin B (wholemeal flour and yeast) both sterile and normal larvæ grew equally well, while on a diet deficient in vitamin B (white flour) the sterile larvæ did not grow so well as the normal ones. It was concluded that, in the case of these two larvæ, the normal symbionts could synthesize the various components of the vitamin B complex in amounts sufficient to meet the normal growth requirements of the larva (see also *Nature*, 152, 506, 1943).

Nervous Control of Intestinal Function in the Earthworm

N. MILLOTT (*Proc. Roy. Soc. B*, 131, 271, 1943) has shown that the intestine of *Lumbricus*, while possessing an intrinsic nervous system of its own, is also supplied by nerves from the central nervous system. There are two such extrinsic systems of nerves, one inhibitory and one excitatory to the intestinal muscle, and the condition is thus parallel to that obtaining in the vertebrates. Further (*Proc.*

Roy. Soc. B, 132, 200, 1944), Millett has shown that stimulation of the extrinsic nerve supply causes the secretion of protease by the glandular cells of the intestinal epithelium. The glandular cells showed the usual histological changes associated with secretion, and an increase of protease was demonstrated in the intestinal fluid. The probable course of the nerve fibres was mapped out by the usual methods of electrical exploration.

Rubidium in Algae and Freshwater Plants

THE presence of rubidium as a 'trace element' in certain plants has been recognized since 1862, when Grandea identified it in the ash of beet and succeeded in extracting no less than 400 gm. of pure rubidium chloride from that source. Rubidium has also been reported in various other plants and plant organs (for example, tobacco leaves) and is usually derived by the plant from traces present in the soil. T. F. Borovick-Romanova, in a paper on the content of rubidium in plants (*C. R. Acad. Sci. U. S. S. R.*, 43, 163, 1944), gives an account of the quantitative spectroscopic examination of the ash from fifteen different seaweeds (*Laminariales*, *Fucales*, *Rhodymeniales* and *Charales*) and from fourteen higher water-plants. The results, which are tabulated to show the percentage of metal in the ash and in the live plant, and also the rubidium-potassium ratio, were checked by comparison with lines produced by addition of definite quantities of barium salts. The rubidium content of the seaweeds is more than ten times that of the sea water in which they grew (2×10^{-5} per cent), while in the freshwater plants it is almost a thousand times that of the medium in which they were found. The rubidium-potassium ratio is higher in the *Laminariales* than in the *Fucales*, the average rubidium content being about 1 per cent of the ash, or 0.005 per cent of the live weight. Among the freshwater plants examined, the water-lilies showed the highest rubidium content, with 6.7 per cent of the total ash from the roots of *Nuphar luteum* (or 0.0052 per cent of the fresh weight). The plants had been collected between 1933 and 1938 from such widely separated parts as the Barents Sea, the Pacific Ocean, the Caspian Sea and the Staroselje reserve of the Ukrainian Academy. Their examination occupied the intervening years and follows a study of the distribution of rubidium in sea waters. It is a part of a survey of the occurrence of rubidium in the biosphere.

Boron in Horticulture

SINCE the first demonstration that boron is an essential element in plant nutrition, boron deficiency in a great variety of crop plants growing in the field has been recorded. Correction of boron deficiency by the use of dressings of borax is not always a straightforward matter, as in many cases the limits of boron tolerance are narrow, and A. S. Heimicke, W. Reuther and S. C. Cam (*Proc. Amer. Soc. Hort. Sci.*, 40, 31, 1942) suggest that the application of borax even to a boron-deficient soil may induce separation of apple fruits from the trees, although this may be the result of an acceleration of fruit development as found by L. P. Batjer and M. H. Haller (*ibid.*, 40, 29, 1942). Usual dressings of borax are of the order of 10 lb. per acre, this amount is sufficient to control boron deficiency in the field in cauliflower, radish, beet and swede (R. H. White-Stevens, *ibid.*, 39, 367, 1941), while half this amount will increase the yield of potatoes and peas on

soils deficient in boron, but where the deficiency is not sufficiently acute for characteristic boron deficiency symptoms to develop. Twenty pounds of borax per acre may be harmful to spinach and carrots, and it is therefore surprising to find that indications of borax injury to eighteen-year-old apple trees did not develop until the applications of borax to the soil had reached the level of 10 lb per tree (L P Latimer and A P Percival, *ibid*, 43, 21, 1943), and these damaged trees showed complete recovery in the following year.

Spraying of Fruit Trees with Growth Substances

A E Hitchcock and P. W. Zimmerman (*Proc Amer. Soc Hort Sci.*, 42, 141, 1943) describe the effects of spraying different fruit trees during the summer with growth substance (potassium α -naphthyl acetate). Peach and plum especially and apple, pear and cherry, to a lesser extent, responded to the treatment by delaying the opening of fruit and flower buds in the following spring. In the same journal, P C. Marth (pp 620-628) describes how exposure of rose bushes during the winter to the vapour of naphthyl methyl acetate retards their shoot development. The magnitude of the response depends partly on the physiological condition of the bushes—'high starch' plants showing a greater retardation of shoot growth than 'low starch' ones. Of theoretical interest, these experiments have a practical bearing also as they offer with rose and fruit bushes a possible method of prolonging shoot dormancy and so escaping some of the damaging effects of spring frosts, and of extending the planting season.

Verticillium Wilt of the Tomato

WILT diseases of the tomato crop are widespread, and though a useful control can be effected by maintaining the temperature between 70° and 74° F, this is not always feasible. Soil factors which affect the pathogenicity of the fungus *Verticillium albo-atrum* have been investigated by F M Roberts (*Ann Appl Biol.*, 30, 4, 327, 1943). Attack by the fungus appears to depend to some extent upon lack of competition from other soil organisms. Inoculation of the ground immediately after steam sterilization gave nearly 90 per cent infection, as against 55 per cent in unsterilized soil. Sterilization thirty-two days before inoculation resulted in only 28 per cent infection. Nitrogenous manures favoured infection, phosphate had little effect, but a deficiency of potash also encouraged the parasite.

Thermodynamic Diagrams of the Atmosphere

CARMELO DI CORLETO has discussed, under the title "Comparación Entre Los Diagramas Termodinámicos De La Atmosfera, Mas Usados En Meteorología" (*Pub Fac Cien Fisicomat*, 3, No 1, Univ. Nac De La Plata), the work of various investigators on the subject of variations in mass of moist air, due to ascending and descending movements. Diagrams based on the work of Hertz (1884), of Neuhoﬀ (1900), and in more recent times of Kreitmeyer, Bjerknes, Stueve, Shaw, Refsdal and Lajtmán are supplied, and the basic assumptions regarding the various conditions, and the formulae derived from these, are briefly discussed. There is a certain amount of discrepancy in the views of different meteorologists on the results of their investigations, to which the author directs attention at the end of the paper. Criticisms

of some of the diagrams are referred to, and the views of Brunt, Rothé and Refsdal on the diagrams devised by Neuhoﬀ, Bjerknes and Shaw are quoted. Comparison of the different diagrams, made in the paper, leads to the view that the preference for any thermodynamic diagram over another is based solely on questions of convenience. Any one of them provides the reader with the conditions of the air so far as atmospheric stability is concerned.

A New Representation of the Types of Nuclear Forces

IN *Revista de la Facultad de Ciencias Fisicomatemáticas*, 3, No 29 (Instituto de Física, La Plata, Argentina), Mario Bunge has a paper with the title, "Una Nueva Representación De Los Tipos De Fuerzas Nucleares". In Section 1 he deals with the fundamental characteristics of the usual representations of nuclear forces and gives a brief outline of the theories of Gamow, Gurney and Condon, Heisenberg and others. Operators are then introduced which are formally identical with those employed in Dirac's theory of the relativistic electron, and these are able to supply an explanation of the four quantum states of the nucleon in non-relativistic approximation. By the employment of this new notation, explicit use of the isotopic spin is excluded, and it is synthesized with the ordinary spin in a single four-valent variable. The various scalar and non-relativistic potentials theoretically possible are formed by means of these new operators, and they are then applied to the problem of the deuteron. At the end of the paper there is a discussion on the advantages and the limits of the representation.

Hydrogen Bond and Diamagnetism

A CRITICAL analysis of the available data by S V Anantkrishnan and P S Varadachari (*Proc Indian Acad Sci*, 20 A, 128, 1944) shows that the contribution to diamagnetic property by the methylene group CH_2 is constant, $\chi_m = 11.69$. On this assumption, it is shown that hydrogen bonding leads to increased diamagnetism, with a susceptibility change of one unit per mol whenever structures of the type $\text{O}-\text{H} \cdots \text{O}=\text{A}$ are involved. A bifurcated hydrogen bond, as in iodic acid, apparently leads to an even larger value. The decrease of diamagnetism in water and alcohols on association is interpreted as due to an increase of the paramagnetic term associated with distortion. The interpretation of structures is considered in the paper.

Fatty Substances in Starch

CONSIDERABLE importance has been attached to the fatty constituents of starch, which interfere with the fractionation of starch and many properties of cereal starch pastes. Since the fat is not removed by a typical fat solvent such as ether or carbon tetrachloride, it has been supposed to be present in the form of esters with starch, but the adsorption of palmitic acid by starch is typical and throws doubt on this chemical theory. R L Whistler and G E Hilbert (*J Amer. Chem Soc*, 66, 1721, 1944) find that the fat is easily removed from disintegrated corn starch granules by methanol, although it is difficult to extract from the intact granules. At the same time the phosphorus content of the starch is appreciably reduced, and the nitrogen content is affected to a lesser degree. All the fatty matter in corn starch (about 1 per cent) is apparently bound by associative forces rather than by primary valency bonds.

SOCIETY FOR GENERAL MICROBIOLOGY

THE inaugural meeting of the original members of the Society for General Microbiology took place on Friday, February 16, at the London School of Hygiene and Tropical Medicine, through the courtesy of the School authorities. Some two hundred members and friends of the new Society were present.

It may be recalled that the Society owed its formation to the preliminary work done by its organizing committee of some thirty members representative of the various disciplines of microbiology, which held its first meeting in London in the autumn of 1943 under the chairmanship of the late Sir John Ledingham. This Committee realized that the lack of contact between the various specializations in microbiology tended to impede the development of the science as a whole, and as the result of several informal meetings it came to the unanimous decision that the time was ripe to promote the advancement of microbiology by the formation of a society which would provide common meeting ground for those working in the various specialized fields. It was decided that the Society should concern itself with the study of bacteria, viruses, micro-fungi, protozoa and microscopic algae in their various biological activities, it being envisaged, however, that contributions to meetings would deal predominantly with the more fundamental aspects of the study of these forms, including their physiology, nutrition, chemotherapy, systematics and ecology. Subsequent meetings were held which were presided over in turn by Dr Marjory Stephenson and Prof A A Miles, and invitations to become original members of the proposed society were sent out by the secretaries, Dr L A Allen and Dr R St John-Brooks, on behalf of the Committee to a number of microbiologists representative of the various fields. This appeal met with a most encouraging response, and as some two hundred and fifty favourable replies were received, the Committee felt that they had ample grounds for proceeding with the inauguration of the proposed society.

Before the opening of the proceedings at the inaugural meeting, the secretaries read a letter which had been received from the president of the Royal Society, Sir Henry Dale, wishing the young Society every success.

Prof Miles, as chairman of the Organizing Committee, briefly recalled the steps that had led to the movement to inaugurate the Society and asked the members if it was their wish that the Society should be inaugurated on the lines indicated in the proposed rules which had been circulated. The members present, having signified their unanimous assent by a show of hands, the chairman formally declared the Society for General Microbiology to be inaugurated. The office bearers who had been proposed by the Organizing Committee for the consideration of the members of the Society were then unanimously elected. They were as follows: *President*, Sir Alexander Fleming, *Secretaries*, Dr L A Allen, Watford, Herts, and Dr R T St John-Brooks, Lister Institute, Elstree, Herts, *Treasurer*, Mr H J Bunker, *Committee*, Dr C H Andrewes, Prof B T P Barker, Prof A W Downie, Dr H B Hutchinson, Dr B C J G Knight, Dr A T R

Mattick, Prof A A Miles, Dr Muriel Robertson, Dr Kenneth M Smith, Dr A W Stableforth and Dr Marjory Stephenson. The late Sir John Ledingham had also been nominated as a proposed member of the Committee, his untimely death creating a vacancy. Prof Miles then asked the newly elected president to take the chair.

In the course of his presidential address, Sir Alexander Fleming said that the meeting had given birth to a new body corporate, which started with a membership approaching three hundred persons, including many of the leaders in the different branches of microbiology. The meetings which the new Society would hold would bring together workers in the various branches of microbiology who might not otherwise meet and who would thus get acquainted and talking together—it was in this way that real advances were made. Thus bacteriologists, perhaps medical, perhaps agricultural, perhaps industrial, mycologists, academic or industrial, protozoologists with various tastes, or biochemists with interests in all fields were now banded together in this new Society of Microbiology. They had grown up separately, and they had been so busy growing up that they never had time to meet and discuss their common problems until now. He stressed the fact that the new Society did not mean to compete with the existing societies, but had its special aim in the correlation of fundamental knowledge regarding the minute animals and plants which formed the basis of all our studies, rather than the application of the science to the many practical problems which were better dealt with by the older societies. There was ample room for all, and the fact that there had been such a general response to the invitation showed that the Society was going to fill a definite gap. The new Society had been born into a troublous world, and the shortage of paper—an essential metabolite!—would prevent it immediately embarking on the venture of a new journal. He thanked the members present for allowing him to preside over the Society's early infancy and he hoped to be spared to watch his successors lead the Society for General Microbiology along the straight path to honour.

The subsequent proceedings consisted of short addresses by selected speakers on various aspects of microbiology. Dr F M L Sheffield (Rothamsted Experimental Station, Harpenden) read a paper which had been prepared by her colleague, Mr F C Bawden, who was absent from the country, on the importance of the study of viruses to microbiology. Prof W B Brierley (Department of Agricultural Botany, University of Reading) spoke on problems of the micro-fungi, illustrated by reference to *Botrytis cinerea*. Dr C A Hoare (Wellcome Research Institution) chose as his subject biological races in protozoa. Prof R H Hopkins discussed the biology of yeasts. Dr A T R Mattick (National Institute for Research in Dairying, Reading) spoke on fundamental problems in dairy bacteriology. Dr Marjory Stevenson (School of Biochemistry, University of Cambridge) took as her theme "Levels of Microbiological Investigation" and Dr W R Wooldridge (London School of Hygiene and Tropical Medicine) read a paper dealing with the contribution of veterinary science to microbiological knowledge.

In concluding the business of the meeting, provisional rules were adopted and an annual subscription of one guinea was authorized—this amount to be adjusted later on when the journal of the Society came into being.

ABSORPTION, EXCRETION AND LOCAL APPLICATION OF PENICILLIN

THE well-known rapid absorption of penicillin when it is given subcutaneously or intramuscularly and its rapid disappearance from the blood and excretion by the kidneys was mentioned in an earlier article (*Nature*, 677, Nov 25, 1944) J H Humphrey (*Nature*, 765, Dec 16, 1944) concluded from a study of two cases of abortion with extreme oliguria that, when there is no significant renal excretion of penicillin, it is slowly inactivated in the body Sir Alexander Fleming (*Lancet*, 620, Nov 11, 1944) describes, with illustrations, the micro-methods which he has devised for the estimation of penicillin in the blood serum and other body fluids In the same issue of the *Lancet* (p 621) Sir Alexander Fleming, M Y Young, J Suchet and A J E Rowe record their work on the penicillin content of the blood serum after various doses have been given subcutaneously, intravenously and intramuscularly, either as single injections or by continuous drip

The results confirm the fact that penicillin is rapidly absorbed after intravenous or intramuscular injection, disappears rapidly from the blood and is rapidly excreted in the urine After three-hourly doses of 15,000 units, the amount of penicillin in the urine is such that it can be diluted 1,000 times or more and still inhibits the standard test *Staphylococcus* The urine of one patient who had had four injections of 15,000 units at intervals of ten minutes contained at one time just after the last injection so much penicillin that it could be diluted 20,000 times before its bacteriostatic power disappeared Penicillin appeared in the blood a few minutes after a subcutaneous or intramuscular injection, so that little is to be gained by intravenous administration On the other hand, little time must be lost, because the rate of disappearance from the blood does not differ markedly after either intravenous or intramuscular administration Measurable penicillin disappears from the blood "somewhat as follows" after it is given intramuscularly 15,000 units in 2-3 hours, 20,000 units in 3 hours, 35,000 units in 4 hours, 50,000 units in 4-5 hours, 100,000 units in 5-6 hours Thus continuous bacteriostatic power can be obtained in the blood much more economically by smaller doses such as 15,000 units than by larger doses such as 100,000 units Six doses of 15,000 units every two hours (90,000 units) will maintain bacteriostatic powers in the blood for 12 hours, while a single dose of 100,000 units will maintain it for only 5-6 hours It may not be possible, however, to give frequent injections, and sometimes a high concentration in the blood may be desirable for only a few hours, for example, during operations through septic tissues The most economical hospital method of administration seems to be by continuous drip, intramuscular drip being in practice the best Much more work is required to decide whether it is better to maintain a constant low level of penicillin in the blood or to have a very high level for a short time after the injection, followed by a period of very low level before the next injection Clinically both systems have worked excellently

Several methods of giving penicillin intramuscularly have been described H L Miles (*Brit Med J*, 118, Jan 27, 1945) describes one such method of giving it over periods as long as four days In the

same issue (p 122), C E Last describes another method for continuous and accurate intra-muscular administration, and F M Berger (p 116) describes a method of preparing penicillin for systemic administration, the product being, he found, effective, non-toxic and painless

In the earlier note in *Nature* referred to above, the experimental attempt to keep penicillin in the body by giving *para*-amino-benzoic acid as well was mentioned This substance apparently delays the passage of penicillin through the renal tubules The *Lancet* (760, Dec 9, 1944) notes another method of economizing it by incorporating it in an oily excipient designed to delay its absorption: Vegetable oils have been tried for this purpose, but have not been satisfactory M J Romansky and G E Rittman (*Science*, 100, 196, 1944) have, however, had some success with mixtures of peanut oil and beeswax, which have been also used for prolonging the action of histamine and heparin Dispersions of penicillin in this mixture retained their potency for 30-62 days either at 37° C, at room temperature or in a refrigerator Injection of 5,000-10,000 penicillin units in 1 c.c. of this oily fluid into rabbits maintained an inhibitory level in the blood for 6-12 hours, as compared with 2 hours for the same dose of penicillin in saline Injection of 41,000-66,000 units in 2-2.4 c.c. of beeswax oil into three human volunteers gave, it is said, "demonstrable blood levels for 6-7 hours and penicillin was present in the urine for 20-32 hours after the injections" There was no local pain or irritation One dose of penicillin in beeswax oil was given to twelve patients with gonorrhoea and eleven were cured Later a single injection cured fifty-three others (*Bull U S Army Med. Dept*, 1944, Oct, p 42, quoted by the *Lancet*)

Because penicillin is thus rapidly excreted and because the supply of it is, in Great Britain at any rate, still limited, the need for economy of it has led to investigation of the value of local, rather than systemic, administration (*Brit Med J*, 699, Nov 25, 1944) H B May (*Brit Med J*, 817, Dec 23, 1944) reports on its use in private practice, concluding that the general practitioner will use penicillin creams more often than other preparations of it and that these should be made readily available, patients could use them themselves H B May and D Stern (*Lancet*, 83, Jan 20, 1945) describe a rapid method for testing the sensitivity of organisms treated with antiseptic creams containing either penicillin, propylamine, sulphanilamide, gentian violet, proflavine and other dyes Another method of local application is by means of the penicillin pastilles for infections of the mouth and throat described by A B MacGregor and D A Long (*Brit Med J*, 686, Nov 25, 1944, and *Nature*, 201, Feb 17, 1945) These authors had unsuccessfully tried sprays for acute tonsillitis They found that a slowly dissolving pastille with a gelatin base, prepared without excessive heat replaced by another when the first had dissolved, kept the saliva fully bacteriostatic The standard dose adopted was 500 units in each pastille The flora of the condition being treated, as well as the general flora of the mouth, were markedly affected Prof L P Garrod (*Brit Med J*, 528, 1, 1944) has noted that most of the bacteria found in the mouth are sensitive to penicillin The penicillin pastilles seem to have controlled the oral sepsis in the relatively few cases treated by MacGregor and Long The symptoms of Vincent's gingivitis (twenty-five cases), the treatment of which by other methods

had been unsatisfactory, cleared up the most rapidly of all. Both *Treponema vincenti*, the cause of this disease, and the symptoms, disappeared in 24 hours, and within five days the ulcerated areas had cleared up so well that the treatment was stopped. No recurrence had been noticed up to 3½ months later. Acute hæmolytic streptococcal tonsillitis (seventeen cases, including four cases of scarlet fever) seemed to respond clinically to the pastilles and the effect on the throat flora seemed to be rapid. Carriers of these streptococci (twelve cases) became negative during treatment, but when the pastilles were stopped, the infection reappeared. This method of using penicillin is clearly promising and, as these authors say, more work on it is required. It certainly seems more promising than the use of sulphonamides in the form of lozenges, for Capt. A. F. Hayden and Lieut.-Colonel J. W. Bigger (*Brit. Med. J.*, 81, Jan. 20, 1945) conclude that these are not satisfactory for the prevention of respiratory tract infections, including coughs and colds.

Yet another means of local application of penicillin are the penicillin lamellæ for eye affections described by Wing-Commander J. C. Neely and Squad Leader A. G. Cross (*Lancet*, 85, Jan. 20, 1945). These authors noted that solutions of calcium and sodium penicillin deteriorate, even at 0°C, and tend to become infected with organisms insensitive to penicillin. They devised lamellæ made with lactose, the use of which in a small number of cases suggests that they are as satisfactory as penicillin drops. They retained their potency for two months at room temperature. Gelatin lamellæ rapidly lost their potency. In an Annotation in the same issue, the *Lancet* (p. 92) remarks that expectations of the value of penicillin for eye infections may not be realized, but that it is the drug of choice for gonococcal ophthalmia neonatorum, and that it is valuable for chronic ulcerative blepharitis, acute gonococcal iritis and for severe infections and war wounds of the eye (given as an irrigation of the anterior chamber). On the other hand, Sir Arnold Sorsby and E. Hoffa (*Brit. Med. J.*, 114, Jan. 27, 1945) conclude, after treating forty-seven infants suffering from ophthalmia neonatorum due to the gonococcus and other organisms with penicillin drops in various concentrations, that penicillin, if it is in adequate concentration, appears to be effective against all the organisms which commonly cause ophthalmia neonatorum, and that the results obtained with it are of the same order as those obtained with the sulphonamides.

Penicillin, indeed, seems to have many advantages over the sulphonamides, its lack of toxicity being one of the greatest. The *Lancet* (55, Jan. 13, 1945) reviews research on the penicillin treatment of gas gangrene (see also *Nature*, 677, Nov. 25, 1944) and quotes work which indicates that penicillin is superior to the sulphonamides for the treatment of this condition. Its precise value requires, however, further elucidation. G. H. Tee (*Brit. Med. J.*, 118, Jan. 27, 1945) reports on the treatment of one case of meningococcal meningitis with penicillin, suggesting that, although penicillin given intramuscularly may not normally get into the cerebro-spinal fluid, it may do so under the abnormal conditions of meningitis. R. E. Rewell, in the same issue (p. 119), describes the treatment of one case of internal hydrocephalus, arising as a complication of pneumococcal meningitis, with penicillin and sulphathiazole. All cases of pneumococcal meningitis should, this author thinks, be given penicillin as soon as possible. G. LAPAGE

BRITISH ELECTRICAL AND ALLIED INDUSTRIES RESEARCH ASSOCIATION

THE twenty-fourth annual report of the British Electrical and Allied Industries Research Association (E.R.A./T. 352) summarizes the work which has been carried out during the year ended September 30, 1944, and again lists, by titles, the various research reports which have been issued during the year. The work is reviewed under the same eighteen major classifications as last year, among which dielectrics, electric control apparatus, and surgical phenomena are prominent. The work of the Association has been carried on during the year by 111 active technical sections, committees, sub-committees and panels, and seventy technical reports on various subjects have been issued as compared with seventy-five in the previous year.

Two outstanding matters mark the conclusion of the Association's year. The first is the retirement of the director, Mr. E. B. Wedmore, and the second is the project for the establishment of new laboratory accommodation at Leatherhead. In view of the necessary expansion of research programmes and the need for achieving results in advance of the practical developments to which they apply, it is becoming increasingly evident that the limiting factor will be the shortage of adequately trained personnel, a condition which can only be relieved adequately by even more extensive pooling of problems of common interest. The Association has now secured control of some forty-seven acres of land at Leatherhead at a cost of about £25,000. Designs for the new laboratories, plant and office accommodation are in the hands of Mr. H. J. Rowse, who has already spent considerable time studying the nature of the activities of the Association's staff, so that the building arrangements may foster and facilitate their work. Plans will be ready for consideration at an early date.

Further diminution of enemy action in the London area and smoother working of industrial organization to take care of war requirements has made possible some increased activity of committees, both those indirectly connected with war products and those concerned with essential contributions of the E.R.A. to all sections of the industry.

The latest agreement with the Department of Scientific and Industrial Research was due to terminate at the end of the year covered by the present report, but the agreements have been extended for a maximum period of two years. In doing so the Department restored the sliding-scale grant to the £1 for £1 basis. It has become apparent that many influential persons in the electrical industry who are not closely in touch with the details of technical and scientific developments are not fully informed of the nature and importance of the use that is made of the Association by the industry. To remedy this, and for the information generally of interested parties, a descriptive illustrated brochure entitled "Co-operative Electrical Research" (E.R.A./R619) has now been prepared and issued. This brochure deals with the past, present and future of electrical research, the activities of the E.R.A. and its association with other bodies in the industry, and an outline of some of the major researches carried out by the Association.

A detailed account of the technical and scientific activities of the Association during the year is given in the body of the report under numerous sectional headings.

igs The co-ordination of all research work connected with the applications of electricity to agricultural and horticultural work is now almost complete plans have been prepared during the year for the establishment of a field station associated with the University of Reading, and a working liaison has been established with the Scottish Hydro-Electric Board.

Special attention has been given to research required for the further commercial development of gas-blast circuit breakers The electric control apparatus section has prepared a further important series of reports for dealing with industrial explosion hazards The importance of work on the creep of steels has been recognized by expansion of the scale of working at the National Physical Laboratory, and some success has been achieved in applying similar ideas in the study of insulating materials subjected to continued high mechanical stresses at working temperatures, a subject representing practically an unworked field until tackled by the Association

Continuous attention has been given to the examination of new insulating materials and to the research necessary for their standardization, and generally to improvements in methods of selection and testing The practical value of applying modern statistical and other scientific methods in the study of electricity supply technology is receiving increasing recognition, and when the War ends will, no doubt, be pursued on a more adequate scale. Several notable reports have been issued during the year applying to surge phenomena, transformer design and meter jewels Work on interference with communication circuits which applied mainly to particular war products has led indirectly to an important new development affording a scientific basis for the design of ignition systems adapted to all types of engines and to varied working conditions

CERAMIC SEQUENCES AT TRES ZAPOTES, MEXICO

THE second season's work of the National Geographic-Smithsonian Institution joint archaeological expedition to southern Veracruz in 1940 has now been described in Bull 140 of the Bureau of American Ethnology* Bull 139, giving an account of the 1939 season's work by G. W. Weiant, has already been noticed in *Nature* (July 22, 1944, p. 124) The aim of the 1940 work, by Philip Drucker, was to follow up the preliminary exploration of 1939 with careful stratigraphical excavations, upon which a ceramic sequence could be based The results indicate no considerable alterations in Weiant's succession of evidence is not absolutely conclusive on every point, but it is sufficient to confirm the suggestion made in the previous notice that his publication was premature

The chief result of the 1940 work was to mark the essential unity and continuity of the Lower, Middle and Upper Tres Zapotes 'periods', which are renamed 'phases' to emphasize the point, and to separate Weiant's Upper period into a true Upper Tres Zapotes phase and an unconformable "Soncautla Complex", consisting of cremated burials (the "cremated burials covered bowls" of the previous notice) intruded into deposits of the Upper phase. The Tres Zapotes

period, *sensu stricto*, is shown to cover an occupation of long duration, after which the site was abandoned, and later used for the Soncautla burials for a short time. So far, the picture is entirely convincing, but Drucker also points out that he cannot confirm Weiant's division of the Middle period into A and B stages, admitting at the same time that this may be due to the absence of A deposits from the places excavated by him

Much of the material found in the 1940 work consists of sherds, and this has imposed a simpler system of classification than Weiant's, in which a relatively small number of wares are based on characteristics of slip, vessel shape and paste The distinguishing features of the Lower, Middle and Upper Tres Zapotes phases are clearly pointed out in terms of these wares The figurines are divided into three main types, the first to appear, which persisted throughout, are hand-made and mostly solid, whereas the other two are found in the Upper phase only, one being hollow moulded and the other large and elaborately modelled by hand, with jointed limbs

A tentative chronology of the site is sketched out, and in this connexion there are two strong indications of an early date in the complete lack of metal and of Plumbate and Fine Orange wares The Lower Tres Zapotes phase is shown to be linked with the early Lowland Maya, to the exclusion of the early Highland cultures such as those of Monte Alban and the Valley of Mexico It is suggested that it was in existence in the first century B.C. The Middle phase is essentially one of transition, but the Upper is marked by a large increase of Polychrome sherds, and the introduction of some new elements which, it is conjectured, may have diffused from Teotihuacan The date of the close of the Tres Zapotes occupation is estimated in round figures as A.D. 1000 This was followed by a period long enough for the accumulation of a certain amount of humus, after which came the Soncautla burials, which are very tentatively ascribed to the thirteenth century

This bulletin shows a very considerable improvement on No 139 in the provision of scales on illustrations and plans. Three misprints in references to plates were noticed plate 18 at the top of p. 41 should be 16, Plate 10 at the bottom of p. 43 should be 14, and plate 56 on line 9 of p. 84 should be 59.

G. H. S. BUSHNELL

FORTHCOMING EVENTS

Saturday, March 17

BIOCHEMICAL SOCIETY (at the Middlesex Hospital Medical School, London, W.1), at 2 p.m.—Annual General Meeting

INSTITUTION OF MECHANICAL ENGINEERS (GRADUATES' SECTION) (at Storey's Gate, St. James's Park, London, S.W.1), at 3.30 p.m.—Mr. A. H. Lloyd "British Machine Tools during the War" (Annual Lecture)

ROYAL PHOTOGRAPHIC SOCIETY (SCIENTIFIC AND TECHNICAL GROUP) (at 16 Prince's Gate, South Kensington, London, S.W.7)—Mr. L. V. Chilton "First Renwick Memorial Lecture"

Tuesday, March 20

ROYAL SOCIETY OF ARTS (DOMINIONS AND COLONIES SECTION) (at John Adam Street, Adelphi, London, W.C.2), at 1.45 p.m.—Dr. A. C. Thaysen "Food Yeast, its Nutritive Value and its Production from Empire Sources"

CHEMICAL ENGINEERING GROUP (SOCIETY OF CHEMICAL INDUSTRY) (joint meeting with the INSTITUTION OF CHEMICAL ENGINEERS) (at the Geological Society, Burlington House, Piccadilly, London, W.1), at 2.30 p.m.—Discussion on "Industrial Research" (to be opened by Dr. E. W. Smith)

ROYAL INSTITUTION (at 21 Albemarle Street, London, W.1), at 5.15 p.m.—Sir Henry Dale, O.M., Pres. R.S. "Nerve Endings and Chemical Transmitters", (3) "Cholinergic Action in Nerve Ganglia. Motor Nerve Endings and Electric Organs"

* Smithsonian Institution Bureau of American Ethnology Bull. 140. Ceramic Sequences at Tres Zapotes, Veracruz, Mexico. By Philip Drucker. Pp. ix+155+65 plates (Washington, D.C. Government Printing Office, 1944) 50 cents

INSTITUTION OF ELECTRICAL ENGINEERS (RADIO SECTION) (at Savoy Place, Victoria Embankment, London, W C 2), at 5 30 p.m.—Discussion on "Apprenticeship and Trainee Systems in the Radio Industry" (to be opened by Dr J Greig)

INSTITUTE OF THE PLASTICS INDUSTRY (at the Waldorf Hotel, Aldwych, London, W C 2), at 6 p.m.—Mr N J L Megson "Plastics at War"

PHARMACEUTICAL SOCIETY (at 17 Bloomsbury Square, London, W C 1), at 7 p.m.—Mr W K Fitch "Pharmacists with the B L A"

Wednesday, March 21

INSTITUTION OF NAVAL ARCHITECTS (at the Royal Society of Arts, John Adam Street, Adelphi, London, W C 2), at 12 noon—Eighty-sixth Annual Meeting

ROYAL INSTITUTE OF CHEMISTRY (joint meeting with the INSTITUTE OF PHYSICS) (at the Royal Institution, Albemarle Street, Piccadilly, London, W 1), at 2 30 p.m.—Prof H T S Britton "The Mechanism of Electrode Measurements"

PHYSICAL SOCIETY (COLOUR GROUP) (in the Physics Department of the Imperial College, Imperial Institute Road, South Kensington, London, S W 7), at 3 p.m.—Dr R K Schofield "The Presentation of the C I E System of Colour Specification"

ILLUMINATING ENGINEERING SOCIETY (joint meeting with the ROYAL METEOROLOGICAL SOCIETY) (in the large Physics Lecture Theatre at the Imperial College of Science, Imperial Institute Road, South Kensington, London, S W 7), at 5 30 p.m.—Mr J M Waldram "Measurement of the Photometric Properties of the Upper Atmosphere"

Thursday, March 22

LINNEAN SOCIETY OF LONDON (joint meeting with the ZOOLOGICAL SOCIETY OF LONDON) (at Burlington House, Piccadilly, London, W 1), at 4 p.m.—Mr I H Burkill "Abnormal Gamopetalous Flowers of the Poppy, *Romneya Coulteri*, and the way in which its Sepals Protect the Sexual Organs", Prof D M S Watson, F R S "Evolution of the Elephants"

ROYAL INSTITUTION (at 21 Albemarle Street, London, W 1), at 5 15 p.m.—Sir Lawrence Bragg, F R S "Some Physical Problems of the Solid State"

ROYAL AERONAUTICAL SOCIETY (at the Institution of Mechanical Engineers, Storey's Gate, St James's Park, London, S W 1), at 6 30 p.m.—Mr R H Bound "Hydraulics for Aircraft"

Friday, March 23

ASSOCIATION OF APPLIED BIOLOGISTS (joint meeting with the GENETICAL SOCIETY) (at the London School of Hygiene and Tropical Medicine, Keppel Street, Gower Street, London, W C 1), at 11 a.m. and 2 15 p.m.—Symposium on "Genetical Relations of Plants and Animals to their Pests and Diseases" (Speakers: Dr C D Darlington, F R S, Dr J Hammond, F R S, Mr M S Pease, Mr J G Carr, Mr W Black, Mr G Cockerham, Mr T J Jenkin and Dr C B Williams)

ROYAL INSTITUTION (at 21 Albemarle Street, London, W 1), at 5 p.m.—Sir Richard Paget, Bart "Is Human Speech Good Enough?"

INSTITUTION OF MECHANICAL ENGINEERS (joint meeting with the INSTITUTION OF ELECTRICAL ENGINEERS) (at Storey's Gate, St James's Park, London, S W 1), at 5 30 p.m.—Mr W B Shannon, Mr C W Pratt, Mr T B Webb and Mr W B Carlson "Expanded Tube Joints in Boiler Drums—with Special Reference to the Battersea High-Pressure Boilers"

Saturday, March 24

ASSOCIATION OF BRITISH ZOOLOGISTS (at the Zoological Society of London, Regent's Park, London, W 1), at 10 a.m.—Tenth Annual General Meeting, at 10 30 a.m.—Dr C F A Pantin, F R S "The Interrelationship of Biology Teaching in Schools and Universities", at 2 p.m.—Dr Stanley Kemp, F R S "Marine Investigations", at 2 45 p.m.—Dr S A Neave "The Work of the Zoological Society", at 3 30 p.m.—Mr J C F Fryer "Zoological Interests of the Agricultural Research Council", at 4 15 p.m.—Dr E B Worthington "Freshwater Investigations"

ASSOCIATION FOR SCIENTIFIC PHOTOGRAPHY (at the Royal Society of Arts, John Adam Street, Adelphi, London, W C 2), at 2 30 p.m.—Mr J H Ridley "An Experimental Approach to Time Lapse Cinematography"

SHEFFIELD METALLURGICAL ASSOCIATION (joint meeting with the SOUTH YORKSHIRE SECTION OF THE ROYAL INSTITUTE OF CHEMISTRY) (at 198 West Street, Sheffield, 1), at 2 30 p.m.—Dr U R Evans "The Principles governing Corrosion Resistance in Metals and Alloys"

APPOINTMENTS VACANT

APPLICATIONS are invited for the following appointments on or before the dates mentioned

ENGINEER AND MANAGER—The Clerk to the Alderley Edge and Wilmslow Electricity Board, 49 Spring Gardens, Manchester 2 (March 21)

ANIMAL HUSBANDRY OFFICER—The Executive Officer, Cornwall War Agricultural Executive Committee, County Hall, Truro (March 21)

ASSISTANT VETERINARY INVESTIGATION OFFICER at the University Agricultural Advisory Centre—The Secretary and Registrar, The University, Bristol (March 24)

PRODUCTION OFFICERS IN THE DEPARTMENT OF AGRICULTURE, Government of Nigeria, for Agricultural Surveys connected with investigations of Diseases of Cocoa—The Ministry of Labour and National Service, Central (T and S) Register, Room 5/17, Sardinia Street, Kingsway, London, W C 2 (quoting Reference No F 3752 A) (March 24)

GRADUATE ASSISTANT to teach MATHEMATICS and SCIENCE—The Principal, Twickenham Technical College, Egerton Road, Twickenham, Middlesex (March 26)

LECTURER IN BIOLOGY in the Cardiff Technical College—The Director of Education, City Hall, Cardiff (March 28)

RESEARCH OFFICER on the staff of the Council for Scientific and Industrial Research (Division of Industrial Chemistry), Melbourne for research work in CERAMICS—The Secretary, Australian Scientific Research Liaison Office, Australia House, Strand, London, W C (April 2)

LECTURER (full-time) IN CHEMISTRY in the Department of Chemistry Leeds College of Technology—The Director of Education, Education Offices, Leeds 1 (April 7)

MATHEMATICS SPECIALIST (permanent) to teach up to Higher School Certificate and University Scholarship standard, and an ASSISTANT (temporary) to teach BIOLOGY and CHEMISTRY to Junior Forms, at the Vardean School for Boys—The Education Officer, 54 Old Steine Brighton (April 7)

PHYSICIST (full-time) at the Radiotherapeutic Centre—The Secretary Superintendent, Addenbrooke's Hospital, Cambridge (April 7)

LECTURER (full-time) IN PHYSICS—The Principal, College of Technology and Commerce, The Newark, Leicester (April 9)

ASSISTANT LECTURER AND DEMONSTRATOR (woman) IN BOTANY—The Principal, Royal Holloway College, Englefield Green, Surrey (April 21)

SECRETARY TO THE SENATE—The Principal, University of London c/o Richmond College, Richmond, Surrey (April 30)

TUTOR IN PHYSIOLOGY—The Principal, Lady Margaret Hall Oxford (April 30)

LECTURER, and an ASSISTANT LECTURER AND DEMONSTRATOR in the DEPARTMENT OF PHYSICS—The Registrar, University College Cathays Park, Cardiff (April 30)

PRINCIPAL—The Secretary, King's College of Household and Social Science, c/o University College, Leicester (May 1)

UNIVERSITY CHAIR OF BACTERIOLOGY tenable at University College Hospital Medical School—The Academic Registrar, University of London, c/o Richmond College, Richmond, Surrey (June 25)

TEACHER (full-time) OF PHYSICS AND MATHEMATICS—The Clerk Northern Polytechnic, Holloway Road, London, N 7

SPEECH THERAPIST—The Education Officer, County Hall, Wakefield, Yorks

PSYCHOLOGIST (part-time) to the Child Guidance Clinics at Huyton and Atherton and Ashton-under-Lyne—The County Medical Officer of Health, School Medical Department, County Offices, Preston

ROUGH ENGINEER AND SURVEYOR—The Town Clerk, Town Hall Wallasey

REPORTS and other PUBLICATIONS

(not included in the monthly Books Supplement)

Great Britain and Ireland

Canterbury Schools King's School and St Edmund's Report of Natural History, Cornwall 1940-1944 Pp 44 (Canterbury King School, 1945) [12]

Institution of Professional Civil Servants Post-War Organisation of Statistics in Government Departments Pp 16 (London Institution of Professional Civil Servants, 1945) [15]

The Importance of Power Unit Development By Air-Commodore F R Banks Pp 20 (London Royal Aeronautical Society, 1945) [13]

Aeroplane Wheels and Brakes By J. Wright Pp 10 (London Royal Aeronautical Society, 1945) [11]

Ministry of Agriculture and Fisheries Bulletin No 123 Diseases of Vegetables By Lawrence Ogilvie Second edition Pp ii+74+4 plates (London H M Stationery Office, 1944) 1s 6d net [14]

Carnegie Trust for the Universities of Scotland Forty-third Annual Report (for the Year 1943-44) submitted by the Executive Committee to the Trustees on the 12th February 1945 Pp iv+62 (Edinburgh Carnegie Trust for the Universities of Scotland, 1945) [14]

Other Countries

Meddelanden från Lunds Universitetets Matematiska Seminarium Band 6 On a Class of Linear Transformations Connected with Group Representations By Lars Gårding Pp 125 (Lund C W Gleerup, 1944) [2]

Proceedings of the California Academy of Sciences, Fourth Series Vol 23, No 40 Two Extraordinary New Blind Nematognath Fish from the Rio Negro, representing a New Subfamily of Pygmatidae with a Rearrangement of the Genera of the Family, and Illustration of some previously described Genera and Species from Venezuela at Brazil By George Sprague Myers Pp 591-602+plates 52-56 (San Francisco California Academy of Sciences, 1944) [3]

Proceedings of the United States National Museum Vol 95, N 3180 Studies in Neotropical Mallophaga (III) (Tinaudae No 1) By M A Carriker, Jr Pp 81-233 (Washington, D C Government Printing Office, 1944) [3]

Scientific Research in India By Prof A V Hill Pp 40 (Simla Government of India Press, 1944) [3]

Indian Forest Leaflet, No 69 A Note on the Protection of Timber from Certain Borer By J C M Gardner Pp ii+4 (Dehra Dun Forest Research Institute, 1944) 4 annas, 5d [2]

Commonwealth of Australia Council for Scientific and Industrial Research Bulletin No 142 A Soil and Land Use Survey of the Hundreds of Raddoch, Hindmarsh, Grey, Young, and Nangwarr County Grey, South Australia By C G Stephens, R L Crocker, Butler and R Smith Pp 55+6 plates Bulletin No 152 S Survey of part of County Moira, Victoria, including the Parishes Booyeah, Cobram, Katamatite, Naringangalook, Katunga, Yarrooeyah, and Strathmerton By B E Butler, J G Baldwin, F Penn and R G Downes Pp 48 Bulletin No 182 The Effectiveness of Various Mineral Dusts for the Control of Grain Pests By Dr J FitzGerald Pp 27 (Melbourne Government Printer, 1941, 1944) [1]

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RATIONALIZATION OF LOCAL GOVERNMENT IN BRITAIN

THE White Paper on Local Government in England and Wales during the Period of Reconstruction* may be pragmatic, but no one could claim that it is bold or imaginative. The assumption that opposition to any drastic innovation such as regional government makes such a step inexpedient during the reconstruction period may be well founded. Furthermore, it is probably true that some improvement in administration might be achieved without abandoning the main features of the county and county borough system, subject to the establishment of appropriate machinery where it is shown to be necessary for combined action by neighbouring areas. But the central, and indeed only, recommendation of the White Paper is the establishment of a Local Government Boundaries Commission. The field of joint authorities is regarded as the most suitable for the development of units of administration where large areas are required, and within its limited field the proposed commission may have considerable advantages. Centralizing in one body, subject to review, all boundary questions, would promote the accumulation of an unrivalled fund of experience and enable the relations of county and county borough, of town and country, to be seen clearly and regulated as a whole. It would also be an advantage to have much of the work done on the spot with a full use of local knowledge, and if the commissioners are skilful in promoting local agreement, it should lead to substantial economies in the cost of boundary alterations.

Part 2 of the White Paper, forming the major section, is devoted to this procedure for adjustment of local government areas. It is frankly recognized that the system of counties and county boroughs cannot be static, but must be capable of adaptation by changing boundaries to meet changing conditions. The proposal to improve the effective machinery for periodic review has been hailed as a solid and promising advance, and the proposed boundary commission appears to meet the conditions put forward in the White Paper, namely, it must command public confidence, it must work smoothly and expeditiously, it should be such as to reduce to the minimum the cost of making the adjustments, and it must ensure that all the proposals affecting a county, whether for adjusting county districts or altering the boundaries between county and county, or county and county borough, are properly correlated and not considered in isolation.

It is not for this positive proposal that the White Paper is to be regarded as weak and disappointingly cautious. It is because the proposal, however sound in itself, only touches the fringe of the problem, and because the analysis of the problem is hesitant and shallow. Nowhere are the fundamental issues laid bare. There is no contribution to that fundamental thinking about the relations of local and central government which is indispensable if we are to evolve

* Cmd 6579 (London H.M. Stationery Office, 1945) 4d net.

machinery adequate to serve the needs of to-day, either at the centre or at the circumference. Finally, as a contribution to the education of public opinion on the issues involved, the White Paper compares unfavourably with those that have been issued on other questions such as employment policy, education, health—with all of which this issue of local government reform is closely concerned. The White Paper, for example, indicates the two main arguments for large units: that many local government authorities are too small to provide the new and extended services required in these and in other fields, and the inadequacy of the present system of local authority finance, based upon property rates, to maintain existing burdens or ensure their independence. But it fails conspicuously to point out that if regional development is inexpedient at the moment, it is on account of local prejudices which have no sound or rational basis, but which it should be the work of time and education to remove. Nor is there any reference to that scientific study of the rating system and its variations in incidence, sponsored by the National Institute of Economic and Social Research, in which Prof. J. R. and Mrs. Hicks have shown the tangle, also disclosed by the Fitzgerald Committee, which must be unravelled before the system can be brought back to life and the independent income of the local authorities substantially increased.

The White Paper, indeed, compares poorly with reports like that of the committee of the National Association of Local Government Officers on the reform of the local government structure, or of the Labour Party on the future of local government, or with Dr. D. M. Goodfellow's "Democracy and Local Government" issued by the Association for Education in Citizenship as No. 12 in the Handbooks for Discussion Groups series. While Dr. Goodfellow only deals incidentally with some of the reasons that are forcing the reconsideration of the relations between local and central government, he indicates clearly enough the weaknesses of the existing system and the questions that should be asked. His pamphlet is admirably designed to stimulate that closer discussion and wider public interest which are indispensable conditions of effective local government reform and of the continued functioning of our democratic institutions. He is concerned with the general question; and while he brings certain aspects of it into clear focus, for example, that of the entry to, and staffing of, the local government service and the reasons for regional proposals, he does not enforce consideration of the problem as an urgent practical issue in the same way that recent Government proposals have done in such fields as those of town and country planning, health and education. Moreover, it is scarcely so suggestive in regard to constructive proposals as Guy. Hunter's admirable pamphlet, "The British Way in Local Rule", in the British Way series. Writing before the publication of the Beveridge Report, Mr. Hunter contributes a critical review of our present social services under

local government and also anticipates strikingly some of the proposals and implications in this field of the Beveridge Report, and the White Papers on Educational Reconstruction and a National Health Service, for example.

In its scheme for educational reconstruction in Britain, the Government could not avoid some revision of the present system of local educational administration to meet the needs of a new statutory system of public education. Whether or not the proposals of the White Paper on local government are those best calculated to preserve and stimulate local interest in educational matters and at the same time secure both efficiency and a really national system, the proposal that the councils of the counties and the county boroughs only shall be the local education authorities, with powers to combine for educational purposes, is advanced from departmental considerations alone. It has no relation to the grouping that might be most profitable from a general or national point of view, and it is already evident that the proposed system offers no safeguard that the outlook and resources of the local education authorities will ensure uniformity in such a matter as the salaries and status of the teachers.

The existence of such dangers is shown very significantly in independent surveys such as McCollvin's report on the public library services, and it is particularly apparent in proposals for a national health service. The Government's White Paper on health starts with the view that there is no case for departing generally from the principle of local responsibility, coupled with enough central direction to obtain a coherent and consistent national service, but it recognizes the need within the administrative structure for some largely professional body which can concern itself with the professional welfare of medical practitioners who take part in the service. None the less, for the future hospital service, it will be essential to obtain larger areas than at present, both for planning and administration. Most of the areas of the existing authorities fail to meet the essential needs of an organized area, namely a population and financial resources sufficient for an adequate service to be secured on an efficient and economical basis; a type where town and county requirements can be regarded as blended parts of a single problem and catered for accordingly, and definition as to allow of most of the varied hospital and specialist services being organized within its boundaries, leaving for inter-area arrangement only a few specialized services. Outside the hospital and consultant service, the Government holds that existing organizations should be upset as little as possible consistent with achieving a unified health service for all. While still conducted locally with all the advantages of local knowledge and enthusiasm, they should be regarded in future as the related parts of a wider whole, and should fit in with all the other branches of a comprehensive service in their planning and distribution. To secure this, the Government proposes a new joint authority, again presumably responsible for planning from a purely departmental point of view.

The argument for some comprehensive regional plan is set forth even more cogently by Sir Arthur MacNalty in the Nu field College paper "The Reform of the Public Health Services". Sir Arthur indicates the imperative need for a large administrative area in respect of the maternity and child welfare services, the school medical service, infectious diseases, tuberculosis, venereal diseases, cancer, rheumatic diseases, as well as hospital services and general practitioner services. He proposes to provide the co-ordinated effort between local authorities by a system of regional health councils, and there is much to be said for such an arrangement, coupled with a Government undertaking to tackle the whole problem of adapting local government machinery to modern needs as soon as circumstances permit.

In health, as in other fields, an adequate programme of reform and reconstruction cannot be executed without creating the appropriate planning machinery at the centre, and forming units large and competent enough to administer and execute the policy over areas large enough for efficiency. The debate on the Town and Country Planning Act in the House of Commons showed how urgent in that field is the need for some adjustment of local government boundaries and resources, or some further measure of Government support.

It must also be recognized that we cannot continue to frame policies for re-building, for town- and country-planning and for the re-organization of education, health and other services, without giving thought to the repercussions of such policies on the structure of local government as a whole. Constructive thought about the principles and whole relation of local administration to the central government is required. It is not sufficient to recognize that certain public services require for their efficient operation administrative areas substantially larger than those of many of the existing local authorities. We must distinguish clearly the contribution which local support and interest can make to the effectiveness of those services, and we must see that departmental proposals are duly co-ordinated and harmonized with one another and with the needs of the situation as a whole. This the report of the Liberal Party Committee on Local Government conspicuously fails to do. The report is disturbing as well as disappointing, not merely for the absence of any constructive proposals, but still more for the refusal to recognize the necessity of some form of regionalism.

Much of the material proper to an inquiry into local government reform and basic to a decision on policy has already been collected and is available in such reports as those of the Barlow Commission and the Uthwatt and Scott Committees. The facts are largely displayed already. The need now is rather for clear and constructive thinking about the facts, analysis of the evidence, the formulation of principles and policy, and the courage to take the necessary decisions to execute a reasoned policy, whether or not that appears to conflict with what may be regarded as the traditional or vested interests of a particular professional body or local council.

In the attempt to view as a whole the effect upon the general structure of local government of the changes in administrative areas which are inherent in the extension of the scope of particular social services, there must first be faced the main question. Should the present tendencies to mark out large administrative areas for each main service, mainly on purely technical considerations, be permitted to proceed unchecked, or should an attempt be made to find a single comprehensive area of large size which would serve tolerably well for the administration of all or most of the extended services? But a decision on this point of area is bound up with questions of the constitution and powers of the new regional authorities. For those there appear to be three possible types: an *ad hoc* authority, a joint authority or a compendious primary authority of the type of the existing local authority. Here again, as in the choice between an elective or nominated body, exercising either executive or advisory powers, the decision must be determined by the view we take of the relation between local and central government, and of the way in which that relation can best give expression to the democratic ideal.

The decisions to be taken do indeed depend on first principles, and whatever intermediate forms of government are evolved must conform to those principles laid bare in the Machinery of Government Report nearly three decades ago. That is what presumably is being considered *inter alia* by the Committee of Ministers and the interdepartmental committee of permanent heads of departments, which already in 1943 were understood to be at work on the machinery of government. It is with that in mind that the present White Paper on local government appears to be so disappointing; so far from laying bare the fundamental issues, it is at pains to cover them up and to temporize.

Given the assurance that the fundamental issues were really being faced and that a serious attempt was being made by the Committee of Ministers and the interdepartmental committee to arrive at a comprehensive solution and not to postpone decision or action, the proposals of the White Paper might be accepted without prejudice so far as they go. Some real effort must, however, be made to deal constructively and nationally rather than departmentally with the outstanding questions, pending the reports of these committees. It must be remembered that it is no bad thing in itself that we should retain the wider freedom of experiment at this juncture that is possible, for example, with local administration, or even with regional administration, in such fields as education and health, as compared with a fully centralized national system, where the consequences of a mistake may be so much more serious. Again, the effectiveness of local government clearly depends on the extent to which it can attract the right type of men and women and secure the wider interest and support of the community. It is part and parcel of that process of re-integration in which civil defence has already shown the way in promising experiments and on which the report of the Commission of the

Church Assembly in "The Church and the Planning of Britain" rightly laid such stress. There above all lies the real solution of the problem of town- and country-planning and the location of industry, of central and local government. Handled wisely, the new extension of the social services, as Sir William Beveridge has been quick to note, gives us opportunities of harnessing to the evolution of a constructive democracy new interests and new forces in an increasing proportion of the population. If that is to be achieved, however, there must be proceeding at the centre, the careful thought, inquiry and analysis necessary to lay down the pattern of organization within which those new interests and forces can function and find effective expression.

Regional government is now inevitable, but it is essential that it should not be a form of provincial bureaucracy, and that it should be viewed and established in the right relation to the local councils and authorities and to the central government, and that there should prevail the spirit of co-operation and goodwill without which no organization can function effectively. It should be remembered that it is the multiplicity of independent local authorities that is the problem. The local council provides and must continue to provide, as Mr Guy Hunter points out, the local leadership, the inspiration to the citizen to make the plan for Britain a plan for his town and street, to give his service voluntarily and with zest; to see a tangible result of local rule and take his part in it. Only at this level can we hope effectively to harness to our post-war purposes, the enthusiasm and unselfishness which have found expression in civil defence; and on the local authority, too, must lie a large measure of responsibility for the execution of our plans for better education, health and other social services. Again, not only will there come locally, within the limits of the regional plan, the internal planning of the town or district, but also the capacity for experiment and variation which is so much harder for the central government to attempt.

At the regional level will come those plans which must cover a wider area, as emphasized in the debates on the Town and Country Planning Act, particularly with reference to the replanning of destroyed cities and the problem of 'overspill', or of population as in Sir Arthur McNulty's proposals for the health service. Here we should seek to achieve the proper balance between town and county, industry and agriculture, between central and local control. Finally, at the national level, under the eye of Parliament, the broad national plan and lines of policy must be determined, the balance held between regions, and the solution of legal and financial obstacles to planning found. Here alone can we look for the slow adaptation of the whole system to the changing needs of the national community, and ultimately of the world as a whole. This can never be achieved without the continuous devolution of local responsibility for the execution of policy as far as possible. If regionalism is required to provide the resources for tackling some of our urgent post-war problems, it is equally required to relieve the central government of some of its burdens. But that

can only be done when there is creative thinking about the first principles of the machinery of government, and the clear enunciation of policy and the taking of decisions which will allow regional and local authorities to proceed in their own sphere with confidence. Hitherto there has been little sign of this at the centre, the Requisitioned Land and War Works Bill is the latest of a series of measures in which national planning is conspicuously absent and in which the Government has eschewed any attempt to see that departmental views and prejudices do not override the general interest even to the thwarting of a national plan.

Courage and vision are the first requirements. courage to grapple with whatever private or vested interests obstruct progress, and vision to see the possibilities of a civil or local government service fitted by training and experience to concern itself with the achievement of immediate concrete purposes. The fear of bureaucracy typified in the Liberal Party report will never allow us to achieve the possibilities inherent in a 'positive' Civil Service wholeheartedly with the people and eager in its struggle for a fuller human life. As John MacMurray has pointed out, under positive government there must be a considerable extension of local rule, and the new conception of the Civil Service and of the functions of central government depend on a lively and effective participation in self government by the general body of citizens. But without courage and the readiness to shed prejudice, we shall never achieve the forms of government which make such participation effective, and at the same time secure the continuous application of scientific knowledge and technique to the betterment of the conditions of human life. To be timid, no less than to be weak, is to be miserable.

BIOCHEMISTRY OF PROTEINS

Advances in Protein Chemistry

Edited by M. L. Anson and John T. Edsall. Vol. 1. Pp. xi + 341. (New York: Academic Press, Inc., London: H. K. Lewis and Co., Ltd., 1944.) 5.50 dollars.

FEW would deny that protein chemistry, in all its aspects, is one of the most important branches of biochemistry. Not only do the proteins constitute a unique group of related compounds containing numerous types and perhaps an infinity of individuals, but also their functions are many and diverse, each type appearing to be adapted to one particular function. They form, for example, hormones, antibodies, genes and, either alone or in association with prosthetic groups, enzymes and respiratory pigments. The proteins clearly offer for investigation a wide field and a multitude of problems, the complete solution of which would probably yield the key to the elucidation of the nature of living matter. On these grounds we welcome this, the first of a series of volumes to be devoted exclusively to advances in protein chemistry. Nevertheless, when we reflect that there already exists an extensive review literature on biochemistry and related subjects, and that much of protein chemistry is inseparable from other branches of biochemistry, we foresee some danger of a considerable duplication of subjects in the various

reviews That such a danger exists is, indeed, apparent from the present volume, which contains several articles dealing with topics which have recently been reviewed elsewhere

It was apparently the intention of the editors to publish in each volume articles by various authors dealing with related subjects. In their preface they state that the second volume will be devoted mainly to protein nutrition, and that in the first "special emphasis is laid on proteins as they occur in nature, as components of complex biological systems" The latter statement is, however, scarcely borne out by an examination of the volume It consists, in fact, of eight articles dealing with widely differing subjects

As is to be expected in a volume of this kind, the articles are of varying quality and interest Some give excellent accounts of the subjects with which they deal As examples may be specially mentioned those dealing with immunology and muscle proteins For those who are not conversant with the relationship of immunology to proteins, the former provides an excellent introduction. The subject and its terms are first concisely explained in such a manner as to render intelligible the description of the more recent work which forms the main subject of the article In our opinion this is a model of what a review should be. In the same category, although dealing with a less extensive field, is the article on muscle proteins The main subject of this is, of course, the protein myosin, and the results described illustrate the inseparability of protein chemistry from biochemistry In myosin one encounters a protein which apparently serves a dual function, probably acting as an enzyme (adenosinetriphosphatase) and also forming the contractile element of muscle In so far as they have been analysed, there is a striking similarity in the composition of the myosins from different species, but the author is wise not to draw the conclusion that all myosins, or even some of them, are chemically identical. Similar resemblances in composition occur among other proteins serving identical functions in different species, and, as is pointed out in the article on immunity, the more nearly related the species from which analogous proteins are obtained the greater is the serological relationship, as evidenced by cross-reactions, between them The diminution in the serological relationship as the species diverge is no doubt due to the proteins becoming more dissimilar in composition This suggests that the species specificity of proteins is, in general, a reflexion of the specificity in the protein forming the genic material of the gametes

Another article deals with the structural proteins of cells and tissue and gives a brief résumé of a recent symposium on cytochemistry But it is chiefly concerned with the results obtained by the examination by physical methods of proteins, or of structures which are believed to consist of protein, or to contain a protein component There are, for example, a few interesting electron micrographs of structures such as sperm tails which illustrate the possibilities of the electron microscope But this must at present be regarded as morphology rather than protein chemistry.

The article entitled "The Purification and Properties of Certain Protein Hormones" is sufficiently described by its title if it is mentioned that it is limited mainly to hormones from the pituitary gland, and does not describe their physiological properties. Those who have always regarded adrenaline as a hormone will be surprised to read in the introductory sentence "All the animal hormones which

have been isolated so far are either steroids, proteins, or polypeptides" Surprise may also be felt at the prospect of the possible revival of Abel's so-called unitarian theory of the hormones of the posterior lobe of the pituitary According to the author, however, a protein apparently possessing the characteristics of a pure substance and exhibiting both oxytocic and pressor activities has been isolated from the posterior lobe.

Short articles discuss soy-bean protein in human nutrition (this might well have been held over for the second volume), the combination of calcium with protein, and lipoproteins.

The longest, and hence the main, article of the volume is entitled "Nucleoproteins". This is comprehensive in scope, dealing with nucleic acid, nucleoproteins, protamines and histones, viruses and cytochemistry This group of subjects undoubtedly constitutes a very attractive section of biochemistry, but unfortunately the treatment of it is marred by the author's discursive style, by the inordinate length of the sections dealing with the obscure phenomenon of the 'depolymerization' of nucleic acid and related subjects, by the over-emphasis of some details and the omission of others, and by the adoption of a descriptive method for recording deductions from the results of cytological experiments, a method which tends to elevate hypotheses to established facts Limitations of space preclude a detailed criticism of this review, but a few specific points may be mentioned.

It is emphasized that the deoxyribonucleic acids in the nuclei of different types of cells may not be identical, but no mention is made of Feulgen's isolation in 1937 of nucleic acid from the nuclei of rye embryos and its chemical identification as thymus nucleic acid, which has an important bearing on this point. On p 214 it is stated that the ribonucleic acid from the pancreas yields the same kind and proportion of bases as yeast nucleic acid This ignores Jorpes' work (1934), which seemed to show that the purine bases were in a different ratio In the absence of decisive evidence to the contrary, this may mean that the cytoplasmic 'nucleic' acid of all animal cells is of the pancreas and not the yeast type. The acceptance, on slender evidence, of the view that a ribonucleic acid is present in nuclei obscures the otherwise established fact that the name nucleic acid is correct as applied to deoxyribonucleic acid but a misnomer for ribonucleic acid The classification of globins as histones is incorrect They differ in their mode of occurrence and composition as well as in their chemical and physiological properties The old analytical data for thymus histone, reproduced in Table IV, are clearly unreliable and should be replaced by the more limited data provided by Felix (1931), which leave no doubt about the presence of sulphur On p 266 it is stated that chromosomes appear "to join and disjoin during separate phases of the mitotic cycle" Kossel's hypothesis of the direct conversion of complex proteins into histones and of histones into protamines, to which so much prominence is given, is improbable and has no experimental basis Finally, the apparent acceptance of the view that chromosomes undergo extensive changes in composition during mitosis necessarily leads to the corollary that the giant chromosomes of the salivary glands of Diptera, which are claimed by geneticists to give a picture of the genetic constitution of the individual in which they occur, differ chemically from the genic material received from the sperm.

E. STEDMAN.

INDUSTRIAL RADIOGRAPHY

Handbook of Industrial Radiology

By Members of the Industrial Radiology Group of the Institute of Physics. Edited by Dr J A Crowther. Pp viii+203 (London: Edward Arnold and Co., 1944) 21s net.

AS Dr Crowther remarks in the introduction to this book, a volume put together as this one is "cannot have the degree of orderly development" that is to be expected in a book written by a single person. Consequently there is a certain amount of overlapping and a noticeable disjointedness which must inevitably occur when a series of discrete papers make up one volume.

The book is timely. During the War the use of X-rays in the inspection and examination of engineering structures has increased enormously, and X-ray inspection has proved itself to be an essential process in engineering development. It is astonishing that such a wide variety of applications of X-ray inspection should have manifested themselves without the appropriate differentiated development in radiographic apparatus. This, of course, may be understandable under war conditions.

The widespread use of X-rays during the War affords a very clear pointer concerning the importance of this branch of science in post-war activity, and there can be no question that the subject will be developed intensively to take its place as perhaps the most important branch of non-destructive testing.

The Radiology Group of the Institute of Physics is indeed to be congratulated on having culled the experience of so many pioneer workers and gathered together their views in the form of these articles. In this book there is very little matter which is not instructive and the collection cannot fail to be of the utmost value to those young scientific men who are now devoting themselves to this branch of technical activity.

It is really undesirable to draw invidious distinctions between papers of such excellence as those collected together in this volume, but special mention must be made of what is perhaps the outstanding contribution by Dr L Mullins—outstanding in the comprehensiveness with which he reviews this subject of industrial radiography. The potentialities of the method, both present and future, are strikingly illustrated by the examples he has collected and described in his article.

Attention should also be directed to another outstandingly useful contribution made by Dr. R. Jackson. In describing his experience in the radiography of heavy steel castings, he provides information of the utmost practical value. Of particular interest is his suggestion of zoning as a method of possible standardization of radiography in relation to the inspection of steel castings. This is a subject of unquestionable importance and one that bristles with difficulties, and Dr Jackson is to be congratulated on the courage with which he has attacked the problem.

There is also a most valuable chapter on physical principles involved in X-ray practice contributed by Mr W J Wiltshire. It cannot be over-emphasized that the would-be industrial radiographer must know something of the physical principles underlying the 'tool' which he intends to use, and Mr Wiltshire has been quite remarkably skilful in putting so much valuable and fundamental information into the short chapter available to him. The first is by no means the least important chapter in the book.

The Institute of Physics has performed invaluable service to industry in having formed a special group for the study and encouragement of industrial radiology. In sponsoring this valuable collection of lectures containing so much practical information it has emphasized that service.

The book under review is described as a "Handbook on Industrial Radiology". Some aspects of industrial radiology are not included, for example, the supremely valuable branch of the subject known as X-ray crystallography. Perhaps "A Handbook on Industrial Radiography" would have been a more generally appropriate title.

V E PULLIN

CONTEMPORARY THOUGHT OF THE RENAISSANCE

Sociology of the Renaissance

(International Library of Sociology and Social Reconstruction.) Translated from the German by W L Luetkiers. By Alfred von Martin. Pp x+100 (London: Kegan Paul, Trench, Trubner and Co., Ltd., 1944) 8s 6d net.

IT is something of an achievement to have written a book, even a small one, about the Renaissance without a mention of Walter Pater. But then he was a gentle creature, whereas Dr von Martin is a little aggressive. Nevertheless, there is much of interest here for the man of science, psychologist and historian, not least because, as the author indicates, the phenomena he describes are of significance far beyond the particular period under review.

Much of the turmoil of those years, the estrangements and the efforts to compromise might well be transported bodily into our experience to-day. In fact, against a background of friction, the essential continuity of the sequence Medievalism-Renaissance-Baroque is exceedingly well brought out, and that alone is worth a great deal. Against it, however, stand a few odd contrasts. An example is the note, referring to the High Renaissance, to the effect that Catholicism was more or less compelled to set the 'here and now' with its stresses and strains, in quasi-opposition to the 'hereafter' with its axiomatic harmony. So far as the *philosophia perennis* goes (and this is supposedly what matters in the present context), such a view is scarcely tenable, since, of all systems, Thomism—whatever its defects—is probably the most comprehensive yet devised, and thus capable of fusing all the various 'knowledge' into something approaching coherence. That it was temporarily decadent is neither here nor there, its potency remained, and in consequence its inherent ability to smooth out the jolts.

Meanwhile, contemporary thought and action were alike obsessed with the boundless possibilities opening up for applied science, art and technics were not seldom practised by one and the same person, notably the peerless Leonardo da Vinci. How bitterly his brother artists complained that he had deserted them for engineering! It was no mere accident that he venerated Archimedes and shunned Aristotle, a point upon which it would be good to have Dr von Martin expound. But there is no mention of it. Leonardo ends almost immersed in numinous rapture over the problem of natural law, while the merry men of the Renaissance carried on until one of the greatest storms in human history had blown itself out.

F IAN G RAWLINS

RONTGEN CENTENARY AND FIFTY YEARS OF X-RAYS

By PROF. J. A. CROWTHER
University of Reading

WILHELM KONRAD RONTGEN was born on March 27, 1845. The discovery of X-rays was communicated by him to the Physico-Medical Society of Wurtzburg in November 1895, a translation of his paper appeared in *Nature* of January 23, 1896. The present year thus marks the centenary of the birth of the discoverer, and the fiftieth anniversary of the epoch-making discovery with which his name is associated. It has sometimes been suggested that the discovery of X-rays was a happy accident, but there is no doubt, from the nature of his preparations, that Rontgen had, as he himself stated, set out to see whether the electric discharge through a gas at low pressure gave out any kind of 'invisible radiation' capable of detection outside the walls of the glass tube in which the discharge was taking place. The discharge tube (an ordinary Crookes tube of the cylindrical pattern, with a flat cathode at one end, and an anode tucked away in a side tube) had been wrapped in black paper, to cut off all the visible glow from the discharge, and a primitive fluorescent screen, consisting of a few crystals of barium platinoeyanide on a piece of cardboard, lay handy on an adjacent bench—barium platinoeyanide being a substance commonly used at the time to detect the invisible rays in the solar spectrum. On exciting the tube by means of a small induction coil to see if the light from the discharge was properly obscured by its black paper wrapper, Rontgen found that this was, indeed, the case, but he also noticed that his primitive fluorescent screen was now glowing brightly. The discovery of X-radiation had been made.

It was as simple as that, but it was not 'accidental', unless it be regarded as a happy accident that Rontgen should have thought it worth while to investigate a possibility so remote from current physical thought that, although research into the physics of the Crookes tube was being actively pursued in some of the leading physical laboratories, no other experimenter had thought it worth while to make the very simple tests involved. Some workers had, in fact, been inconvenienced by the fogging of photographic material kept in the same laboratory as their Crookes tubes, but, finding that the trouble could easily be overcome by storing the material elsewhere, they proceeded with the researches on which they were engaged without further thought or hindrance.

Rontgen showed that the new X-radiation affected a photographic plate, and he was able to take a photograph through the thickness of a stout pine-wood door separating two of his laboratories. He also noticed that a strip of beading, which had been stuck on the door panel with white lead, cast a distinct shadow on the negative, the thin layer of lead being much more opaque to the radiation than the wood itself. Thus the foundations of the science of radiography were laid.

Both for its practical importance, and for its immense value as a tool for further research, the discovery of X-rays ranks high among the germinal discoveries of physics. The power of the radiation to penetrate considerable thicknesses of materials opaque to ordinary light, and to cast shadows of structures

of greater or smaller density concealed within them, caused considerable popular excitement, and had obvious possibilities. The fact that the discovery was first communicated to a medical society has been taken as an indication that Rontgen immediately foresaw its importance in medical diagnosis, though the possibility that he merely took the readiest means of establishing his claim to what was clearly a discovery of first importance cannot altogether be overlooked. However this may be, the new radiation was taken up by members of the medical profession in all countries, in Britain among the first, with a zeal and devotion quite beyond praise. The pioneers among them began work with apparatus little more effective than, and quite as troublesome as, that with which Rontgen made the original discovery. A radiograph of even such an easy subject as the human hand required an exposure measured in minutes. Gradually, however, the insistent demands of the medical radiologists for more and more penetrating power, and shorter and shorter exposures, bore fruit. With the realization that there would be a substantial market for X-ray equipment, engineers became interested in the problem, and the modern diagnostic set is capable of producing excellent radiographs of any part of the human body in a matter of seconds, and with little more trouble to the operator than would be involved in switching on an ordinary electric lamp.

Progress in the interpretation of the radiographs has been equally marked. In medicine, X-rays have evolved from an exciting novelty into a standard routine. Some of the pioneers are with us still, others, we recall, as in duty bound, lost their lives through their devotion to their work, since the dangerous nature of the radiation was not at first realized.

It is not the purpose of this brief article to sketch the story of the evolution of medical radiography, but its recent invasion of the field of preventive and social medicine deserves at least a passing notice. Mass radiography, that is to say, the routine radiography of all workers, has already begun, and will undoubtedly be extended as conditions permit. In such diseases as pulmonary tuberculosis, early diagnosis is nine-tenths of the battle, and the presence of the disease can often be identified by radiography long before any physical symptoms occur to direct attention to it. In a recent survey of some 20,000 operatives, some 1½ per cent were found to be affected, and were sent for treatment. Thus some three hundred workers will owe their escape from serious incapacity, and possibly from a premature death, to this development of Rontgen's discovery of X-rays.

The use of X-rays in the treatment of disease has scarcely made such satisfactory progress as its use in diagnosis. Many malignant growths, sarcomas, carcinomas and the like respond rapidly to the action of radiation, and fade away under its influence as if by magic. For many types of these scourges upon humanity, X-radiation, either alone or accompanied by radium radiation (which, after all, is only a kind of naturally occurring X-radiation), is by far the most hopeful treatment, and no great hospital is complete without a well-equipped and well-staffed radiotherapy department. It must be confessed, however, that there is as yet an uncertainty about the action of the rays which is very tantalizing. Complete success appears to be so near, and yet continues to elude us. The action of the X-rays on tissue cells, whether healthy or diseased, is, it must be

understood, always destructive, the possibility of using X-rays to cure disease rests on the fact that malignant cells are, on the whole, less resistant to the action of the rays than healthy tissue. Some of our troubles are undoubtedly due to the difficulty of administering a lethal dose to the malignant growth without damaging the surrounding healthy tissues. This is, primarily, a problem in physics; and the appointment of qualified physicists to the staff of the radiotherapy departments, which is now becoming general, will undoubtedly lead to some solution in due course. Probably a more vital handicap has been that little or nothing was known of the way in which the radiation exerted its destructive powers on the cell. Treatment, therefore, has had to be largely empirical. Recently, however, thanks to ingenious co-operation between physicists and cytologists, it begins to look as if a breach had been made into the problem. If so, not only may methods of treatment gain in certainty, but also X-rays may add a new chapter to our knowledge of the living cell, as they have already added more than one to our knowledge of the atom.

Industry, on the whole, was slower to grasp the utility of X-rays than the medical profession. Some small amount of radiographic testing of materials for hidden defects was carried out during the War of 1914-18, mainly in connexion with aeroplane construction, in which the importance of ensuring the complete soundness of every part justified the very considerable skill and trouble involved in making radiographs with the comparatively primitive apparatus then available. Gradually, however, the value of X-rays as a non-destructive method of investigating the soundness of castings, weldings and other industrial products received fuller recognition, and the number of industrial radiologists, in this second World War, must very greatly exceed that of medical radiologists. The demands of industry, even more effective than those of medicine, since they are backed with much larger capital, have resulted in still greater advances in the design of X-ray apparatus. Million-volt X-ray tubes, enclosed with the high-tension generator which feeds them in a single unit weighing three-quarters of a ton, are now on the market, and in heavy industry (in which they are mainly employed) are regarded as quite portable. With such an outfit, successful radiographs can be made through a 6-in. steel plate, and, under suitable conditions, cracks or flaws of no more than a tenth of an inch in thickness can be detected with certainty.

To one who began X-ray work not many years later than Röntgen's original discovery, the contrast between one of these huge but obedient 'genii of the lamp' and the miscellaneous and extremely temperamental assortment of physical apparatus with which Röntgen first revealed the existence of X-rays (and which, with a few minor improvements, served experimenters for the next twenty years or so) is astounding. By their creation, applied science has gone far to repay the debt which it owes to pure science for the discovery of the radiation. When times are again favourable, pure science will no doubt respond by using these powerful tools to make still fresh discoveries. Nor has the limit yet been reached. A two-million volt tube, some 10 ft. long, is now in operation, while another carries (for a millionth of a second) a current of 2,000 amperes at 300,000 volts, and has been employed for making instantaneous radiographs of the passage of a high-velocity shell through a 1½-in. armour plate.

Still higher voltages, accompanied by still greater penetration and power in the radiation, is promised by a new type of generator, working on entirely novel principles, which has recently been constructed in the United States. From this machine, which has been christened the 'betatron', X-radiation at energies up to thirty million volts can be obtained. When it is remembered that the most penetrating radiation from radium is equivalent to X-radiation at only two million volts, it will be realized that the betatron carries us into an entirely novel and unexplored region of the X-ray spectrum. Such radiation will penetrate not merely the outworks, but also the central citadel or nucleus of the atom, and its effects, particularly in radiotherapy, are quite unpredictable. They may be beneficial, or disastrous, but it is evident that we cannot afford to leave them unexplored. It is greatly to be hoped that the various bodies in Great Britain, whether Governmental or voluntary, interested in radiotherapeutics, and particularly in cancer research, will make the necessary provision for British research workers (who have already done so much, often with painfully inadequate resources) to play their part in the quest.

It is natural, in tracing the consequences and developments of Röntgen's discovery, to dwell first on its more immediate applications. X-radiation was, however, one of those germinal discoveries, which are at least as important for the new knowledge which they make possible as for their direct utility. Coming, as it did, a year or so before the complementary discovery of the electron by Sir J. J. Thomson, it opened the way to entirely new regions of experimental research, including the structure of atoms and molecules, and the nature of radiation itself. It may well be that when the final balance comes to be struck, the importance of X-rays as a means of winning fresh knowledge may be judged to outweigh their more directly utilitarian merits.

A knowledge of the nature of the rays was a necessary preliminary to their intelligent application in further research. The true explanation was put forward by Stokes within a few months of Röntgen's discovery. He suggested they were electromagnetic pulses produced by the sudden stoppage of the electrified particles carrying the discharge, and therefore of the same nature as light (though probably of much shorter wave-length). So far, however, did Röntgen's discovery stand apart from the general trend of the physical thought of the time, that there was an interval in which some physicists were inclined to associate the radiation with the vivid fluorescence of the glass walls of the Crookes tube, which is an invariable accompaniment of the electric discharge. Becquerel was led to investigate whether X-rays were also given off by naturally occurring fluorescent materials. Uranium was one of the substances tested, and thus the natural radioactivity of uranium was discovered. The isolation of radium, by the Curies, followed. Thus the whole science of radioactivity may be regarded as a direct offspring, though perhaps an illegitimate one, of Röntgen's discovery.

Although Stokes's suggestion was soon generally accepted, and was supported by Barkla's demonstration that X-rays, like light, could be polarized, progress was at first slow. Such evidence as there was indicated that the wave-length of the radiation must be of the order of one ten-thousandth of that of ordinary light, and attempts to apply the diffraction

methods used in determining optical wave-lengths seemed almost hopeless. It was not until 1912, when Laue suggested that the regular spacings of the atoms in a crystal might serve as a naturally occurring diffraction grating for X-rays, that real progress was made. The suggestion was immediately verified by Friedrich and Knipping, and in the following year W. L. Bragg, by a most ingenious combination of crystallography and optical theory, succeeded in determining simultaneously the grating constant of a rock-salt crystal, and the wave-length of the X-radiation employed.

This achievement has a double significance. If the spacing of the atoms in a crystal is known, we can, from diffraction measurements, determine the wave-length of the radiation impinging upon it, and thus obtain an X-ray spectrum. Conversely, if the wave-length of the radiation is known, we can deduce the spacings or lattice constants of the crystal. Thus, in the X-ray spectrometer, crystallography has found a most powerful research tool which has given quite a new impetus to this rather old-fashioned science. The practical importance of X-ray crystallography in metallurgy can scarcely be over-estimated. Since each chemical compound has its own unique set of lattice constants, it is possible to identify, not merely the elements present in a given substance (a task for which ordinary spectroscopy or chemical analysis will suffice), but also the actual compounds which these elements form with each other, and the temperatures at which these compounds form, or at which they disappear. When the field has been fully surveyed, and the X-ray crystallographic index which is already in active preparation is completed, it will be possible to identify any crystalline compound in an alloy or mixture by X-ray analysis. Nor is the field limited to true crystals. Many long-chain organic substances are sufficiently regular in their make-up to act as X-ray gratings, and much information, valuable both on the theoretical and the industrial side, has already been obtained (to quote only one example) on the structure of the fibres used in the weaving of textiles. To understand why substances behave as they do, in terms of the position of the atoms within them, is the first step in a scientific search for new and better materials, and X-ray crystallography seems destined to play a part in industry even more important than in radiography.

To attempt to survey the part played by X-rays in atomic research would involve the recital of the greater part of the history of that part of the subject dealing with the structure of the electron atmosphere which surrounds the central nucleus and on which most of the chemical and physical properties of the atom depend. Most of our exact knowledge—and it is very exact—of the arrangement, or to be more precise, the energy-levels, of the electrons in the atom, is derived from X-ray data. It may be recalled that Moseley's early survey of the characteristic X-ray spectra given out by the elements provided the first clear demonstration of the fundamental importance of the idea of atomic number, that is to say, the charge upon the atomic nucleus as opposed to the atomic weight, which was shown to be of only secondary importance. It is interesting to notice that Moseley's results showed that four elements still remained to be discovered, and that two of these have since been identified by their X-ray spectra. It may also be mentioned that the most accurate determinations of the two fundamental physical constants, the charge on an electron and Planck's

constant, are, in all probability, those derived from X-ray measurements.

The temptation to moralize on the history of the discovery of X-radiation, and its consequences, is strong, but the task may be left to the reader. Nature is full of surprises, and it is not always the most obviously desirable researches which yield the richest harvest. The lone experimenter who is prepared to follow his own inspiration, even if it seems to lead him away from the main current of research, has often played an important part in the progress of science, and pure science in particular, and society in general, owe much to the inspired curiosity of Wilhelm Konrad Rontgen.

DIFFRACTION METHODS IN MODERN STRUCTURAL CHEMISTRY

IN the Tilden Lecture delivered before the Chemical Society on January 18, Prof. J. M. Robertson outlined first the scope, limitations and possible future developments of the X-ray and electron diffraction methods, and then went on to consider the nature and lengths of bonds with particular reference to the results of recent diffraction studies. The emphasis throughout was on organic structures, as would be expected from one who has contributed more than any other single worker to our knowledge of the precise crystal structures of organic compounds.

In comparing the electron and X-ray diffraction methods, a number of points were brought out. The great value of the former is that it is applicable to gases and the vapours of easily volatile substances, which cannot conveniently be studied by the X-ray method. In this sense the two methods are complementary. We might add that, as regards inorganic compounds, they are complementary in another sense. In general, the same finite molecules exist in the vapour as in the crystals of an organic compound, but this is not usually so in inorganic chemistry. Electron diffraction studies of the vapours of many metallic salts and of some of the compounds of non-metals give information about the structures of molecules which do not exist in the crystalline material.

A comparison was made of the nature of the experimental data obtainable by the two methods and of the ways in which they are interpreted. To the eye the electron diffraction photograph shows merely a number of rings on a background of decreasing intensity, and their positions and intensities are estimated visually. The X-ray photograph from a single crystal, on the other hand, shows a large number of discrete spots, and the positions and intensities of these can be determined with considerable accuracy. This apparent advantage of the X-ray method is, however, offset by two complications. First, the molecules in the gas scatter independently of one another and they are oriented in all possible ways. This makes it possible to calculate the diffraction effects to be expected for any given molecular model and to compare them with those observed, the parameters in the model being varied until agreement is obtained. In the case of diffraction by a crystal, this cannot be done. In the crystal the molecules are definitely oriented with respect to one another, so that not only has the molecular model to be varied

but also the mutual orientations, and hence the intermolecular distances. Secondly, it is usually impossible to utilize more than a small fraction of the X-ray data on the photographs. Apart from purely technical difficulties, which can eventually be overcome, there is a complication inherent in the X-ray method, namely, that the structure amplitude F_{hkl} corresponding to a particular reflexion is a complex quantity with an amplitude and a phase constant. From the observed intensity we can in general determine only the amplitude. Except in certain cases, therefore, it is necessary to work by a trial and error method based on a probable molecular model which is progressively refined as the structure-determination proceeds. The difficulty of determining phase constants may sometimes be overcome by making comparisons of data from isomorphous compounds or by studying crystals containing heavy atoms. If we assume complete ignorance of phase constants, then all the X-ray data are summarized on a Patterson vector diagram which is directly derived from the observed intensities. An analogy was drawn by Prof. Robertson between the Patterson method for X-ray diffraction and the radial distribution method for electron diffraction. Apart from the difficulty of interpreting Patterson diagrams, owing to the overlapping of peaks, there is the more fundamental difficulty that the same vector diagram (and hence the same X-ray diffraction pattern) may arise from different arrangements of atoms. The discussion of the uniqueness of the solutions of diffraction problems may appear to some chemists rather academic, especially as Prof. Robertson emphasized that a structure must always be consistent with all the other available physical and chemical evidence. However, while it is true that in the case of simple structures there is seldom any doubt as to the correct interpretation of the data, it is important, as the compounds studied become more and more complex, to re-examine the fundamental theory of all methods of interpreting diffraction data.

When discussing possible future developments, Prof. Robertson emphasized the need both for making fuller use of the experimental data and for improving its range and quality. He pointed out that many of the difficulties now encountered in making precise analyses are not fundamental, "and there is no doubt that they can be overcome, largely by the proper planning and organisation of the research, which will have to be on a fairly large scale". Although hopeful that diffraction methods will eventually give information about the positions of hydrogen atoms and about electron densities in bonds, he was careful to indicate some of the difficulties of interpreting the finer details on electron-density maps. On the whole, it would seem advisable to defer drawing conclusions from two-dimensional electron-density projections, and possibly to make detailed studies of the effect of temperature on electron-density distributions in selected crystals using sections through three-dimensional summations, in order to discover the effect of the thermal movements of the molecule as a whole and of different parts of the molecule relative to one another. More emphasis might have been placed on an essential difference between electron and X-ray diffraction, namely, that the nuclei are more effective than the orbital electrons in scattering high-speed electrons, whereas the scattering of X-rays is due to the orbital electrons alone. It is difficult to see how the electron diffraction method in its present form can provide information comparable with the

electron-density maps derived from X-ray studies of crystals. Also, just as the thermal vibrations in solids result in the blurring of these maps, so the greater flexibility of some molecules in the vapour state makes it difficult, or even impossible, to obtain a complete picture of the molecule by the electron diffraction method. For example, the Sn-I distance in SnI_2 can be determined, but not the I-Sn-I bond angle. Provided the molecule possesses sufficient rigidity, however, quite complex structures may now be studied by the electron diffraction method, as shown by the recent work on pyrylene, diphenylene and tri-(phosphonitrile chloride).

Diffraction methods not only provide information about the general configurations of molecules but also they lead to accurate determinations of interatomic distances and inter-bond angles. The X-ray method, of course, gives data on intermolecular as well as intramolecular bonds, and although the weak van der Waals bonds are of comparatively little interest to the chemist, much valuable information about hydrogen bonds has been obtained from studies of crystals. A feature of modern structural chemistry is the detailed analysis of data on bond-lengths with the object of discovering more about the nature of the bonds. At one time 'chemical' bonds were regarded as either ionic or covalent, and in the latter case as single, double or triple bonds. The present view is that all bonds, other than those between atoms of the same element, have some ionic character and also that bonds intermediate between single and multiple bonds exist in many molecules. Bonds of these intermediate types are described in terms of resonance between structures with different arrangements of bonding electrons.

Prof. Robertson discussed the 'order' of carbon-carbon bonds. The C-C distances for pure single, double- and triple-bonds are well established, 1.54 Å in diamond, 1.34 Å in ethylene and 1.20 Å in acetylene. Assuming 50 per cent double-bond character in benzene ($\text{C-C} = 1.39 \text{ Å}$) and 33.3 per cent in graphite ($\text{C-C} = 1.42 \text{ Å}$), Pauling, Brockway and Beach constructed a curve relating percentage double-bond character to bond-length, from which can be estimated the amounts of double-bond character of other bonds with lengths between 1.54 and 1.34 Å. The more detailed calculations of 'bond order' which predict minor variations in length among the bonds in molecules such as naphthalene and coronene cannot yet be checked as the differences are of the same order of magnitude as (or less than) the present experimental errors. This illustrates the need for more precise determinations of interatomic distances. On the other hand, there appear to be some abnormal bond-lengths which cannot at present be accounted for theoretically.

Dealing with bonds between unlike atoms, Prof. Robertson mentioned the recent revisions of certain of the Pauling-Huggins radii, so long adopted as the basis for discussions of interatomic distances. Observed distances which were less than the sums of these radii were considered exceptional, and elaborate explanations in terms of partial ionic character and partial double-bond character have been put forward. With the new (higher) values for the covalent radii of nitrogen, oxygen and fluorine, many bond-lengths are now seen to be appreciably less than the sums of the appropriate covalent radii, even where there is no likelihood of partial double-bond character. The empirical relationship of Schomaker and Stevenson attributes these differences to the ionic character

of the bond, and uses the electronegativity coefficients of Pauling to correct the sums of the Pauling-Huggins radii. In other words, the fact that bonds are shorter than the sums of the true covalent radii is on this later view assumed to be due in many cases to the partial ionic rather than the partial double-bond character of the bonds. In view of the importance now to be attached to Pauling's electronegativity coefficients in discussions of bond type, it is well to remember that our difficulties in this field are an indication that we have not so far solved one of the most complex and fundamental problems in chemistry.

The early electronic theory of valency assigned electronic formulae to many molecules, but offered no explanation either of the observed inter-bond angles or of the differences in properties between atoms with the same number and arrangement of valency electrons. As regards bond angles, it was necessary to find a way of investigating the 'group properties' of a number of valency electrons, and this problem has been solved to some extent by the methods of wave-mechanics. We are still, however, far from being able to account for the chemical properties of an atom. Although elements of a group such as the halogens, all with similar sets of outermost electrons, have certain characteristics in common, nevertheless each halogen has a distinct 'individuality' and the changes in properties do not all run parallel with the increase in size (or atomic number). Thus although the properties of the atoms are to some extent determined by their outer electronic structures, the finer differences between atoms which are similar in this respect will not be explained until we are able to take into account the effect of the nuclear charge and the remaining shells of electrons.

Until we find some theoretical way of specifying these distinctive chemical properties in terms of the structure of the isolated atom, they can only be estimated from the way in which the atom interacts with other atoms. The use of the electronegativity concept represents an attempt to deal with the problem in this way. The electronegativity coefficients are derived from experimental observations on the interactions between atoms, namely, from bond energies. The new empirical relation connecting actual bond lengths with true covalent radii and electronegativity coefficients simply expresses the fact that the difference between the length of a bond $A-B$ and the arithmetic mean of $A-A$ and $B-B$ is related to the difference between the energy of the bond $A-B$ and the arithmetic mean of the energies of the bonds $A-A$ and $B-B$. Some relationship is obviously to be expected, it was not apparent earlier because incorrect radii had been assigned to three of the most electronegative elements. It is, however, relevant to inquire whether the same relationship should apply to all pairs of dissimilar atoms, that is, whether the nature of a bond is the same for any pair of atoms with a particular difference in electronegativity regardless of the absolute values of the electronegativity coefficients. It will also be necessary to inquire into the general validity of Pauling's curve relating the percentage ionic character of a bond to the difference between the electronegativities of the atoms, a curve based on the dipole moments of the halogen halides. For example, are we justified in assuming that two electrons are shared in exactly the same way between two fluorine atoms as between, say, two carbon atoms, and is the relation between bond type and electronegativity the same

for atoms in a horizontal row as in a vertical column of the Periodic Table? The difference between the electronegativity coefficients of carbon and silicon is greater than that between those of, say, carbon and nitrogen, yet Pauling quotes the carbon-silicon distance in tetramethyl-silane as an example of the additivity of covalent radii.

In order that future discussions of the nature of bonds shall be put on a sound basis, it is to be hoped that some of these points and some of the experimental data will be critically examined. The results are of great general interest to many chemists, of whom relatively few may be in a position to criticize the conclusions reached by the specialist. This is one of the dangers attending the increasing specialization which is a characteristic of modern science. Perhaps there is still room for a Carneades, of whose function Boyle (in "The Sceptical Chymist") wrote, "that having thus drawn the chymists' doctrine out of their dark and smoky laboratories, either judicious men shall henceforth be allowed calmly and after due information to disbelieve it, or those abler chymists will be obliged to speak plainer than hitherto has been done, and maintain it by better experiments and arguments".

A. F. WELLS.

THE SCIENCE OF PLANT BREEDING

By D. LEWIS

John Innes Horticultural Institution

THAT breeding is an art and not a science is an opinion frequently expressed by many who are concerned with plant and animal improvement. Whatever they have meant by art in this generalization, it appears that, in their hands, breeding is mainly unscientific. It is certain, however, after reading Dr Harland's report on cotton breeding in Peru¹ that, in his hands, breeding is truly scientific and as such can give good results quickly. It is scientific because measurements of the relevant characters were his standards for selection, and because genetical principles were the guide in calculating the number of plants required, and in deciding the type of breeding. Therefore, he did not rely upon the hazards of hit-and-miss intuition of the art side of breeding.

Tangurs, originating as a chance seedling in 1908, has been the main variety of cotton grown in Peru since that date. It was originally of excellent quality and yield; but subsequent contamination from crossing and seed mixing with other stocks has caused much deterioration. In 1940 Harland had the task of reviving and improving its characteristic qualities, and in three years he has increased the mean fibre length by $\frac{1}{8}$ in. above the mean for commercial *Tangurs*, and has also made improvements in ginning percentage, boll weight, colour and yield. So that in 1943, 2,100 acres were planted with his improved seed.

How was this remarkable achievement brought about? The taxonomic position and origin of the variety *Tangurs* are first considered, since these are prerequisites to any scientific breeding programme. *Tangurs* has most of the characters of *Gossypium barbadense* with the early maturity of *G. hirsutum*, as a result of which previous Peruvian workers believed it to be a hybrid. But some early work of Harland showed that it is pure *barbadense* and that the early maturity arose by selection due to associa-

tion with *hirsutum* in mixed plantations and not to intercrossing between them

The objectives of the work, nine in number, included improvement in such characters as yield, fibre-length, colour and disease resistance. In a description of his work, Harland examines and criticizes the orthodox pure-line breeding, which has been slavishly adhered to by many breeders. The advantage of a pure line is the uniformity of the commercial product, and he concluded that the value of this has probably been overrated, at least in cotton. For example, fibre-length from single seeds was found to be almost as variable as that from commercial bales made up from plants of diverse genotypes. On the other hand, the disadvantage of early fixation of the genes (favourable and unfavourable) has sometimes been overlooked, as effective selection is then confined to the original plants and the first selfed generation. In the past, far too few original plants have been used to provide sufficient genetic diversity for selection. As Harland shows, it is necessary, in theory, to start with 1,024 strains in order to obtain eight strains which will be above the average in seven characters at the end of selection. Furthermore, when a good pure line has been found, it is not necessarily good in the majority of the environments that any good commercial plant is likely to encounter. Lack of plasticity does not allow the slight adjustments by natural selection which would occur in a mixed population.

For the purpose of maintaining a certain degree of diversity from which further selection would be possible, and also for obtaining effective results quickly, Harland abandoned pure-line breeding. No self-fertilization was practised, and mixtures of strains were propagated. Selection was started on 22,000 boll samples, each taken from a single plant, from various commercial fields. A first selection based on all characters rejected all but 2,863 of them. Ten plants of each selected strain were grown, and bulk samples of the ten plants were examined for all characters. This not only saved much labour in single-plant selection, but it also eliminated heterozygotes which, although themselves good, produce bad offspring by segregation. Forty-one strains survived these bulk tests, which after single-plant selection provided two hundred plants for progeny testing. Two thousand seedlings were raised from these, and after subjecting them to bulk and single-plant selections forty-three strains finally remained. Ten of these were propagated, giving sixty-three strains in the following year. These were mixed together and distributed as commercial seed.

Thus Harland has been able to restore the good qualities of the cotton plant in Peru, and indeed to add further improvement in a very short time while retaining genetic diversity for further selection. In grasses, mixed strains have been bred at the Welsh Plant Breeding Station and utilized with success². Hitherto it has been thought that, in respect of the requirements of variation, pasture crops were different since less uniformity is necessary than in more highly specialized crops, but in view of the success in cotton the mixed strain is worthy of trial in other plants. It should be especially useful in crop plants which suffer from pests and diseases in epidemic form, when genetic heterogeneity may prevent widespread destruction.

¹ Harland, S. C., "The Selection Experiment with Peruvian Tangus Cotton", Inst of Cotton Gen, Lima, Peru, Bull No 1 (1944)

² Stapledon, R. G., "The Breeding of Herbage Plants, etc", Imp Bur of Plant Gen, Bull No 3 (1931)

OBITUARIES

Prof J. K. Catterson-Smith

JOHN KEATS CATTERSON-SMITH, professor of electrical engineering at King's College, University of London, was born on December 27, 1882, and died on January 25, 1945. His father was a well-known artist who became head of the Birmingham School of Art. The son received his early education at the City of London School and then entered the University of Birmingham. Here he held the Bowen research scholarship during 1902-4 and published the results of investigations on transformers, direct current motors and rotary converters. After three years at Siemens Dynamo Works, Stafford, he returned to academic life as lecturer in electrical engineering, and after a period at the University of Liverpool became chief assistant to Prof Silvanus Thompson at the City and Guilds of London Technical College, Finsbury.

Between 1904 and 1914 Catterson-Smith published a number of papers on the starting of motors, on commutation in direct current motors, on harmonics in three-phase networks and on the manufacture of large turbo-alternators. He also contributed to the theory of transformers, induction motors and cascade motors. In 1915 he joined the Navy in the R N V R and was sent to help enlarge the wireless station at Demerara. Upon returning to Portsmouth he took part in the new developments of thermionic radio apparatus, especially in connexion with submarines. He served at sea in submarines and was promoted to lieutenant-commander. In some of the radio and supersonic developments he and I collaborated at Portsmouth and Toulon, and in particular we solved the problem of synchronizing an electric motor with a tuning fork, in preparation for facsimile transmission. Some of this work was done at Finsbury, after he had returned to his old post. Here, also, he published papers on audio-frequency amplifier design and on the theory of intervalve transformers.

In 1918 he married Miss Rita Thom and settled down to academic life again at Finsbury, but in 1923 he was offered the professorship of electrical technology at the Indian Institute of Science, Bangalore, where Sir Martin Forster was then director. At Bangalore he spent several ardent years building and equipping new laboratories, installing heavy-current plant and inaugurating a wireless research laboratory. He founded the Institute journal *Electrotechnics* and probably wrote most of it during its infancy. He and his wife, I have been told, assisted greatly in promoting the social life of the Institute.

In 1930 Catterson-Smith was appointed professor of electrical engineering at King's College, London, in succession to Ernest Wilson. Among his original researches of this period are those on the paralleling of large transformers, and on the theory and measurement of positive and negative sequence components of three-phase currents and voltages in three-wire unbalanced networks. Then came the War and the College moved to Bristol.

In the domain of electrical engineering Catterson-Smith will be remembered for the originality of his experimental work, for the careful workmanship of the apparatus he constructed and for his lucid exposition of what may be called the physiology of electrical machines—which ranged from large turbo-alternators to electric kettles and electric toys. His was one of those minds that restlessly endeavoured

to improve the operation of every machine encountered, his mental processes consisted in first gaining a thorough insight into the operation of the existent machine and then applying remedies to the weaknesses disclosed. This passion for improving and inventing continued to the end of his life. For example, during the last two years he had been working on an improved electrical tele-mechanism of great ingenuity.

In Catterson-Smith there was an unusual and happy blend of art and science. His artistic instincts called for craftsmanship and appropriateness, his scientific instincts for accuracy and efficiency. These qualities imbued all his work. In addition, he possessed a personality of great friendliness and charm. No wonder he gained the affection of all his students and colleagues.

W H ECCLES

Prof James Muir

By the death, on February 17, of Prof James Muir, emeritus professor of natural philosophy in the Royal Technical College, Glasgow, there has passed a great teacher and a man singularly devoted to science and to the quest of knowledge for its own sake.

Dr Muir was born in 1875, and his early interest in science was stimulated by his education at Allan Glen's School, Glasgow. On leaving school, he entered his father's business, but the influence of his school training led him to consult Prof James Blyth, on whose advice he entered his evening class at the Technical College. Thus began a connexion with that College which was to remain unbroken throughout his life.

Muir graduated BSc in 1896 at the University of Glasgow, with special distinction in engineering and astronomy, and DSc in 1902, having obtained the associateship of the College in mathematics and physics in 1897, in which year he was awarded an 1851 Exhibition Scholarship at Cambridge. His researches at Trinity College, under Prof Ewing, into the effect of temperature on recovery from overstrain were published in the *Proceedings of the Royal Society*, and he was awarded the BA degree of Cambridge, followed in 1904 by the MA. Returning to Glasgow, he became chief assistant to Prof Blyth, and then assistant to Prof Andrew Gray at the University of Glasgow.

In 1906, on the death of Prof Blyth, Dr Muir succeeded to the Freeland chair of natural philosophy in the Technical College, Glasgow, and he entered upon his duties with a boundless enthusiasm which continued during the thirty-two years which ended with his retirement in 1938.

Prof Muir always gave foremost place to his teaching and to the interests of his large classes of day and evening students. Nevertheless, he found time to use to the full the resources of his department in conducting many valuable researches on behalf of the industrial firms of Glasgow, and during the War of 1914-18 these researches were directed to the service of the country. He willingly and enthusiastically entered into any movement for promoting the welfare of the College, such as the work of the *College Research Journal* and the re-arrangement and cataloguing of the founder's library.

Prof Muir will always be remembered as a great teacher whose constant aim was to induce his students to think for themselves, to abhor anything slipshod

and to enjoy hard work as he himself enjoyed it. The sincerity and love of truth shown in his scientific work was carried into his everyday life, 'he nothing common did or mean', nor could he compromise upon ethical principles. His students, like all his immediate colleagues, grew to look upon him with affectionate respect; they found him always approachable and eager to share and stimulate their interests. On his retirement, as an expression of their admiration and regard, his former students and colleagues founded and endowed the James Muir Prizes in natural philosophy, and presented to the College the fine portrait by David S Ewart which now hangs in his old lecture room.

Dr Muir's tastes were simple and his wants were few. From his student days he had a great love of the Scottish hills, and friends have most pleasant memories of holiday climbs in his company. At the time of his death he had prepared the manuscript of a text-book on physics and he was engaged on a memoir of the founder of the College. Prof Muir was unmarried and is survived by three sisters.

Mr F R. S. Balfour, C.V.O.

By the death of Frederick Robert Stephen Balfour on February 2, arboriculturists and horticulturists have lost a valued friend and counsellor. Though primarily an arboriculturist he was also a keen naturalist and a true lover of all kinds of plants. He had the advantages of having the means of travelling and of inheriting from his mother the beautiful estate of Dawyck in Tweeddale which possessed a number of interesting and historical trees. In later life he had important business interests in the City of London, and it was probably his business ability which led him to include experimental forestry plots on a large scale at Dawyck.

Balfour was born on March 11, 1875, and was educated at Loretto and Trinity College, Oxford. In his early days he spent four years on the Pacific coast of North America, and, although he was greatly interested in all the plant and animal life, it was the trees which captivated his imagination. He was familiar also with the trees of eastern Canada and the north-eastern States and had a working knowledge of the wonderful forests of south Chile. He became, therefore, a recognized authority in Great Britain on American trees, especially conifers. When he returned to Scotland he developed the collection of North American trees at Dawyck, introducing several species for the first time, his favourite being the rare *Picea Breweriana*, and trying out practically every species which could be expected to survive. In addition to his New World conifers he had also a collection of the more hardy Asiatic species mostly introduced by E H Wilson, whose second expedition to China he helped to finance. He had a great knowledge of British birds and was proud of his notable collection of foreign ducks and pheasants. From the economic point of view his most important contribution to silviculture concerned the trial of promising, but as yet unfamiliar, species under forestry conditions or on the mountainside.

Balfour's published communications are scattered throughout a number of journals; his account of David Douglas, his "History of Conifers in Scotland" which covered a wide field, and a paper read recently before the Linnean Society on Archibald Menzies being perhaps the most noteworthy.

As a member of the Home Grown Timber Com-

mittee, Balfour was sent to France as liaison officer to the French Government during the War of 1914-18, with reference to the supplies of timber. He was one of the founders and remained a most active member of the Roads Beautifying Association, being at his death chairman of the technical sub-committee. His wide love of plants was shown by his zeal in supplying material for figuring in the *Botanical Magazine*.

Balfour had been a fellow of the Linnean Society for many years and had served on the Council of the Royal Horticultural Society, the latter bestowing on him in 1927 its highest award. He had been a member of the King's Bodyguard for Scotland since 1900 and was made C.V.O. in 1944. His other interests included history, architecture and music, he himself possessing a fine baritone voice. But no notice of him would be complete without emphasis on his exceptional courtesy and charm, which were due largely to his understanding and sympathy and to

the genuine pleasure it gave him to do good to his fellow-man.
A D COTTON.

WE regret to announce the following deaths.

Mr F Bligh Bond, formerly director of excavations at Glastonbury Abbey, on March 8, aged eighty.

Mr. G V Boys, secretary of the Institution of Naval Architects since 1935, on March 15, aged fifty-one.

Sir Thomas Lewis, CBE, FRS, physician-in-charge of the Department of Clinical Research at University College Hospital, London, on March 17, aged sixty-three.

Mr P. W. Paget, a technical assistant of Marconi during his early work in England from 1896 onwards.

Prof Stanislaw Zaremba, sometime professor of mathematics in the University of Cracow, and a member of the Polish Academy of Science, aged eighty-one.

NEWS and VIEWS

Chair of Biochemistry at Sheffield

Prof. H. A. Krebs

THE University of Sheffield has conferred on Dr H. A. Krebs the title and status of professor of biochemistry in recognition of his eminence in the world of science. Dr Krebs was awarded the degree of M.D. (Hamburg) in 1925 and that of M.A. (Cambridge) in 1935. He held the post of research assistant at the Kaiser Wilhelm Institute for Biology, Berlin-Dahlem, during 1926-30 under Prof Otto Warburg. After further experience in Germany he became a Rockefeller research student in the Biochemical Laboratory, Cambridge (1933-34), demonstrator in biochemistry at Cambridge (1934-35) and lecturer in pharmacology at Sheffield (1935-38). In 1938 he was appointed lecturer in charge of the newly created Department of Biochemistry in Sheffield, and attracted to his department research workers from both Europe and America. He is a naturalized British subject, and during the War he has given valuable service in connexion with diet and nutrition. His main contributions to biochemistry are in the field of intermediary metabolism. He showed that the synthesis of urea in the mammalian liver is catalysed by ornithine. This observation led to the formulation of the 'ornithine cycle', according to which ornithine, citrulline and arginine are intermediate stages in the synthesis of urea. His work on the oxidation of carbohydrate in muscle showed that this metabolic process, too, is a cyclic one (known as the 'Krebs cycle'), where a series of organic acids arises periodically.

Prairie Regional Laboratory, Canada

Prof R. K. Larmour

PROF. R. K. LARMOUR, professor of chemistry in the University of Saskatchewan, has been appointed director of the Prairie Regional Laboratory which is to be built in Saskatoon by the Canadian National Research Council. Prof Larmour served in the War of 1914-18, and following his return from overseas, he graduated from the University of Saskatchewan and carried out postgraduate work in the University of Minnesota, where he was Shevlin fellow. He joined the staff of the University of Saskatchewan in 1927

and has remained there ever since except for a short period when he occupied the chair of milling industry at a mid-western American university. Dr Larmour has a high reputation in the field of grain research. The Prairie Regional Laboratory will be concerned primarily with investigations into the utilization of agricultural crops. It will be provided with facilities to undertake all phases of laboratory and pilot-plant investigations in this field.

Colonial Development and Welfare Bill

THE essential feature of the new Bill dealing with Colonial development, which should be of interest to administrators, scientific men and technologists, and all who are concerned with the welfare and advancement of the British Colonial possessions, is that it represents a notable extension of the Colonial Development and Welfare Act of 1940. The extension concerns both the annual provision of funds and the period over which they will be available. Put briefly, whereas the Act of 1940 made available a sum of £5,000,000 per annum for development and £500,000 per annum for research, until 1951, the new Act makes available, unless 'Parliament otherwise determines', a sum of £120,000,000 for all purposes during the period 1946-56. A commendable elasticity, which all who are responsible for new schemes whether of research or development will appreciate, is a feature of the new enactment. Thus it is explicitly stated that no time limit is imposed on schemes of research and investigation and up to £1,000,000 can be spent on such schemes in any one year. For all purposes, up to £17,500,000 may be expended in any one year.

Few will disagree with these measures. Substantial help for the Colonies has been long overdue. Now, it is reasonable to hope that definite schemes may not only be planned and set in motion but also actually carried through to fruition. Readers of *Nature* are already familiar with the very diverse developmental, constructional, sociological and research projects which require and are receiving attention under the Colonial Development and Welfare scheme. In particular, it may be pointed out that members of university staffs and of the teaching profession in Britain, as also in the Dominions and in the Colonies,

have a very real responsibility for the successful outcome of the new Bill. The key to success can be stated in a single word: personnel. Personnel for administration, technology and research. The production of suitable candidates for the many and varied jobs is the task of the schools and universities. In these days it is one beset with difficulties, and it may well be that some years must elapse before suitable staff for some of the research posts, for example, in biology, can be produced. But the task lies clearly before us. The sooner we begin, the better for the welfare of the British Colonies.

Science, Poetry and Religion

THREE lectures delivered by Mr Geoffrey Hoyland at Woodbrooke Summer School in 1944 have now been printed as a challenging and picturesquely written booklet entitled "The Tyranny of Mathematics" (S.C.M. Press, Ltd., 56 Bloomsbury Street, London, W.C.1. Pp 52. 1s 6d. net). Mr Hoyland's theme is the age-old dichotomy between the emotional and the rational approach to human problems, but his treatment is fresh, partly owing to his vivid style, and partly because it is unusual to find a religious apologist with a good knowledge of science and mathematics. It is not possible here even to summarize his arguments and exhortations. His conclusion, briefly, is that since the Renaissance, and particularly since Newton and Leibniz added the weapon of the calculus to the armoury of the man of science, we have worshipped at the analytical shrine of mathematics, to the exclusion of the true gods of poetry and religion, which, with science as their handmaid, can't alone reveal to us the whole truth about the universe. "If our sick world is to be saved the lover and the poet must take control."

Few men of science will go the whole way with Mr Hoyland, preferring to believe that a constantly adjusted partnership between the emotional and rational elements in life, rather than the supremacy of either over the other, is the most fruitful treatment of the dichotomy (and indeed the only one that would justify the use of the word 'symbiosis' in the subtitle), but many will be stimulated by this keen analysis of the problems involved, and enjoy the colourful language in which it is couched.

Cultivation of Rhubarb

RHUBARB is one of the oldest cultivated plants, for its history in China, its native home, dates back to almost 3000 B.C. At first it was grown solely for the medicinal properties of its roots and was introduced into England from Siberia on that account some three hundred years ago. Later, interest developed in the edible properties of the leaf stalks, but it was not until the nineteenth century that plantings of rhubarb for culinary purposes became widespread. The literature on rhubarb cultivation is scanty, so the illustrated bulletin, compiled by H. V. Taylor and E. E. Skillman, recently issued by the Ministry of Agriculture (No. 113. H.M. Stationery Office. 9d.) should prove a great asset to growers. The advice given relates generally to normal peacetime practice. Only a limited number of varieties are grown for commercial purposes, each is described in some detail and attention directed to the fact that all may be seen growing in the gardens of the Royal Horticultural Society at Wisley. The chief area of production is the West Riding of Yorkshire, though in Essex, Lancashire and Cheshire quite a considerable acreage is devoted to the crop. The high rain-

fall, acid soil and the capacity of the plant to withstand smoke pollution contribute to the success of the crop in the Leeds district, in fact the contaminated atmosphere is an asset for forcing purposes, as it induces premature leaf shedding and early dormancy. The cultivation of both forced and natural rhubarb are described at some length and a section devoted to grading, packing and marketing. As regards diseases, that termed 'crown rot' appears to cause most trouble. Eelworm infection is now thought to be largely responsible for this, though it is not yet clear whether there are not also other factors which contribute to this condition.

Plea for a Museum for Croydon

DR H. W. DICKINSON's presidential address this year to the Croydon Natural History and Science Society discussed the proposal for a museum for the district. Croydon is the largest borough in Great Britain without an adequate museum service, and he stated that the Society is now urging the proposal upon the local authority "as one of the particular objects to be carried into effect in the post-war municipal reconstruction scheme". If the museum materializes, he stressed the importance of a localized policy, and in this connexion suggested that a plan already exists in the form of the Society's Regional Survey of the district. Alluding to museum functions, he placed 'research' before 'visual education', but in view of the present-day urgent need for all forms of education, the smaller regional museums might usefully reverse this order. Dr Dickinson justifiably deprecated the use of old dwelling-houses for museum purposes, for these do not provide the offices and facilities required for the execution of a useful and progressive service. Referring to the reluctance of municipalities "to spend money on buildings even if they own valuable collections", he reminded the audience that the Nuffield Trust, and the Carnegie United Kingdom Trust, could be approached for financial help. Clearly, Dr Dickinson has closely studied Markham's report on "The Museums and Art Galleries of the British Isles" (1938), and all authorities undertaking the establishment or reorganization of regional museums in the future could profitably follow his example.

The Cinema

MR LINDGREN's pamphlet "The Cinema" (English Universities Press, Ltd. 4d. net) well maintains the standard set in this Handbook for Discussion Groups series, and should serve as a useful basis for discussion of various aspects of the cinema, including the Report of the Board of Trade Committee on Tendencies to Monopoly in the Cinematograph Film Industry, of which little has been heard since its publication. This particular aspect is indirectly touched by one of the subjects listed for discussion, but in the brief compass of nineteen pages Mr Lindgren contrives to supply a good deal of background and to indicate most of the broader issues involved, such as the possibilities of the cinema in scientific research, education, the recording of history, the promotion of international understanding and the field of public information. He touches succinctly on the general problems of the entertainment value of the cinema, its influence and the question of censorship, where in two brief paragraphs he brings out the essential weaknesses and dangers inherent in censorship, and incidentally supplies adequate justification for the attempt to stimulate further discussion.

of the whole problem. There is an eminently practical note in the whole pamphlet, and if a word of criticism is called for, it is that the bibliography, even within the limits set, might have been improved.

The Cooper Union Annual Report

THE report of the Director of the Cooper Union, of New York, for the year ending June 30, 1944, covering the eighty-fifth year of the Institution, indicates that, although in some respects the disturbance of education in the United States under the impact of war has been less profound than in Great Britain, the problems of demobilization and of re-training are being faced along similar lines. There is an interesting parallel between educational thought, as portrayed in this report, in the two countries. Stress is laid upon the necessity of finding a strong and socially satisfying ethical foundation for modern education, on the limitations of the scientific method, and on the importance of no longer confining instruction and discussion in the human and spiritual values to the level of higher education and the liberal arts. The humanities and the social sciences should be brought into the curriculum of the high school, vocational school, junior college, technical institute and engineering school. The Department of Humanities of the Union has been successfully experimenting since 1939 with the integration of social and humanistic studies with the curricula of the schools of engineering and art, and is now offering a sequence of studies which, taken as a whole, should give a perspective of the history of Western culture and an appreciation of their roles as citizens and as individuals.

The report recognizes that the professional world of engineering and art properly demands a breadth and depth of preparation and a sophistication which cannot be gained by conventional class-room routine. The Cooper Union has been able to keep the nucleus of the teaching staff of its School of Engineering reasonably close to normal in the war period, and resumption of full teaching loads after the War can therefore be undertaken with speed and efficiency and with only minor additions to the staff. Policies to be followed with regard to the re-training of the demobilized and their integration into academic and social life are indicated, and a sub-committee of the Engineering Faculty has set itself the task of determining those qualities and attributes which should characterize the products of the four engineering curricula. Reference is also made to the work of the Student Health Service in educating the student in the use of the facilities already existing in the surrounding community, and of the Division of Social Philosophy, which completed its first decade during the year, in the field of adult education.

Museums and Adult Education

AN editorial article in the *Australian Museum Magazine* (June-August, 1944) directs attention to the contribution which museums have already made towards adult education. At the same time, it points out that there still remains the necessity for far greater extensions of the museums' services in this direction. It is suggested, for example, that museums should be available to the public out of ordinary working hours, that there should be better accommodation for study, and that there should be an increase of suitably qualified staff to guide and assist students.

Society of Public Analysts and Other Analytical Chemists

THE annual general meeting of the Society of Public Analysts and Other Analytical Chemists, held on March 9, marked the seventieth anniversary of the Society. In the past year the membership of the Society increased by 117 to 1,197, and the circulation of the Society's journal, the *Analyst*, in spite of paper restriction, increased. In pursuance of the policy decided upon a year ago, the Society recently formed, within the framework of its constitution, two Groups concerned with particular branches of analysis, namely, the Microchemistry Group (chairman, Prof. H. V. A. Briscoe, hon. secretary, Mr R. Belcher, present membership, 143) and the Physical Methods Group (chairman, Mr R. C. Churnside, hon. secretary, Dr F. Wokes, present membership, 115). These Groups will hold meetings from time to time in London and elsewhere. The proceedings terminated with the presidential address of the retiring president, Mr S. Ernest Melling, who, after reviewing some of the outstanding events of the past year in the Society's affairs, made some observations on the subject of water and water supplies. Dr G. W. Monner-Williams was elected president for the present year.

Science Masters' Association's Annual Meeting

THE annual meeting of the Science Masters' Association will be held during April 9-11 at the City of London School. The president, Mr C. L. Bryant, will speak on "The Impact of Science on Common Thought". The proceedings will include lectures by Dr J. McG. Bruckshaw on "Physics and Economic Geology", Mr C. Bibby on "Health Education through School Biology", "Penicillin", by Sir Alexander Fleming, "Scope and Limitations of the Science Teaching Film", by Mr A. Elton (at the Ministry of Information Theatre), "The Electron Microscope", by Mr F. W. Cuckow, "Chemistry of Plastics", by Mr R. Mantland, and a discussion on "The Role of Science in the Future Educational System". There will also be the usual exhibitions. The third lecture on the Science and Citizenship Foundation will be delivered by Mr J. G. Crowther, who will speak on "The Social Relations of Science", this lecture is open to the public, and tickets for visitors can be obtained from Mr W. Ashhurst, Epsom College, Surrey.

Announcements

THE Bristol Aeroplane Company has given £60,000 to the University of Bristol for the establishment of a Sir George White chair of aeronautical engineering, in memory of the founder of the Company.

THE Biochemical Society and the Nutrition Society have arranged a joint whole-day conference on "The Vitamin B-Complex", to be held on April 28, at the London School of Hygiene and Tropical Medicine, Keppel Street, W.C.1. Details of the programme will be published later.

PROF. JAMES MACKINTOSH, dean of the London School of Hygiene and Tropical Medicine, is visiting Sweden to lecture for the British Council on aspects of social medicine and health education in Britain. He will probably also visit Finland. Prof. Mackintosh hopes to obtain in Sweden information for inclusion in a report on housing which he is preparing for the British Government.

LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications.

Presentation of Scientific Data

WORKERS in certain branches of science have to carry in their heads many numerical results and constants, and to read and abstract a vast literature. This becomes even more arduous for those on the borderline between the exact and the descriptive sciences. The difficulties are greatly increased by the less rigorous presentation of borderline results, and by the less stringent editing of journals dealing with a variety of subjects. In chemistry and in physics the symbols and quantities are standardized, but in the applications little regard may be paid to recognized usages. A report drawn up by the Chemical, Faraday and Physical Societies in 1937 listed symbols for thermodynamical and physico-chemical quantities. These were accepted by the Royal Society in 1939. There are, however, many quantities not included in the list. For these, reference to the International Critical Tables or to the Smithsonian Tables is helpful. One major difficulty arises from the fact that the Greek letters and diverse founts of type are lacking on ordinary typewriting machines.

For numerical results it is suggested that, if possible, indices should be avoided, and when used they should refer to the basic unit. Though one may write 17 cm, it is preferable to avoid 17×10^{-4} cm and to write 17×10^{-6} m, or better, 17 μ . This would be an aid to memory.

It would be a convenient convention if droplet sizes were given as diameters, rendering comparable, for example, the length of a bacillus and the diameter of a coccus with spray droplets. But at present those who measure droplets give diameters and those who carry out mathematical investigations give radii.

It is very confusing when quantities in the same analysis are given in different units. Workers in nutrition are offenders in this. For lack of better, they have to give certain quantities as I.U. (international units), but there is no defence for giving in consecutive lines of a table a vitamin as 19 μ gm/gm and iron as 1.9 mgm/100 gm, whereas in fact the two quantities are identical. It would appear simpler to give both results in parts per million. Why do they darken understanding by reporting such quantities as per ounce of, say, bread? Surely micrograms are meaningless to workers in ounces, but anyone can understand percentages, parts per thousand and per million. Why write 10^{-8} oz? It sounds ridiculously small and indefinite, but is actually slightly less than 0.3 μ gm. One may be surprised at detecting a substance "even in a concentration of 1×10^{-10} g per μ^3 ", but the feat is more credible when bluntly put as 0.1 gm per litre.

It is somewhat of a shock to find depths of corrosion pits given in thousandths of an inch (mils) and the thickness of the overlying paint in microns, but to give the application of paint in square feet per gallon (Imperial or U.S.A.) is convenient and logical, with just this drawback, that it renders the determination of film thickness—simple in the metric system—quite complicated. Also one wonders why anyone should be allowed to report permeability "as milligrams of water per day per square centimetre of film area per mil of film thickness", or a liquid for

destroying insects in cubic centimetres per 37 cubic feet of air, instead of using the factor 2360 to convert to the same unit of volume and reporting as parts in 87,000, or per 100,000. All the cases instanced have been met with recently. Furthermore, why do physiologists speak of the tension of oxygen, when they mean the pressure—and why, when a paper went to the Chemical Society giving the boiling point of a pure liquid as so many degrees at so many millibars pressure, was it sent back for conversion to millimetres of mercury, though the Meteorological Office publishes the atmospheric pressure in millibars? Could we not be a little more consistent—and spare our memories unnecessary figures? Could we not in technical reports use the metric system universally and translate such quantities as have workshop application into the British system—where necessary? At present there is often a medley of both systems with a vast waste of time in conversion from one unit to another. In measuring light we have even got to the mile-candle. Before autumn one may find candles per acre. After the War, Britain will be poor, so why should we handicap our scientific and technical development by carrying an antiquated system of measurement into new fields? But for those who have to convert, the British Standards Institution Publication 350 (1944) Conversion Factors and Tables is useful.

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Feb 12.

Sublimation in a Wilson Chamber

As a result of some experiments on the deposition of water vapour at low temperatures, it was found that the liquid phase can frequently exist much further below the freezing-point than was expected. For example, droplets of super-cooled water can be obtained at -50°C without difficulty. It appeared also that the number of nuclei in atmospheric air on which water vapour could form ice crystals without the previous formation of droplets was small, and they appear to be active only below about -40°C . Arrangements were therefore made to repeat Prof. C. T. R. Wilson's classical experiments below the freezing-point, both in thoroughly clean air and in ordinary atmospheric air. The following results were obtained.

Air thoroughly cleaned by repeated expansions

(1) Provided that the lowest temperature after expansion (that is, the temperature when expansion is finished and condensation just starts) does not fall below -35.0°C , only liquid droplets are formed, however big is the expansion ratio.

(2) If the lowest temperature after expansion falls to -35.1°C ($\pm 0.1^\circ$) a few ice crystals are formed among a much larger number of droplets. As the minimum temperature falls further below -35°C , more ice crystals and fewer droplets appear, so that at lower temperatures a fog of ice particles is formed. Whether or not the solid phase appears depends only on the minimum temperature and not at all on the supersaturation.

(3) Provided that the lowest temperature after expansion falls below -35.0°C , ice crystals are formed although the expansion is below the normal critical ratio.

(4) When the lowest temperature after expansion falls below about -80°C , the number of particles formed decreases and a few of them change in appearance from transparent ice crystals to much larger grains of soft hail. At about -100°C only a few such grains fall down after expansion. Below about -120°C no particles are formed. The result does not depend on the expansion ratio, provided it is big enough to make the products visible.

(5) If the air be ionized by X-rays before the expansion, the density of the ice cloud formed is very greatly increased, but the limiting temperatures are not altered.

Ordinary atmospheric air (1) The limiting temperature of -35.0°C found for clean air becomes -27°C , and varies by $\pm 0.5^{\circ}\text{C}$ from one experiment to another. With air artificially contaminated with tobacco smoke the limiting temperature for the appearance of ice was as high as -23°C .

(2) At the lower temperatures (-80° to -120°C) the same decrease in the number of particles and the same changes in their appearance occur as in thoroughly clean air.

During the course of experiments, the expansion chamber was surrounded by a cooling bath of different temperatures, all below freezing point. A certain test to indicate the presence of the minutest amount of ice was to have supercooled water in the bottom of the expansion chamber. If any ice appeared in the chamber, it could not escape detection. It could not melt because all the surroundings were below freezing point. Within a few seconds, any ice particles which may be formed would seed the super-cooled water either by falling to the bottom or by contact with the film of super-cooled water coating the walls of the chamber. Then the water would freeze.

Some preliminary investigation of the properties of super-cooled water made it possible to use this indicator for initial temperatures of the chamber between 0°C and -10°C . Samples of a few cubic centimetres of water which can be easily supercooled were prepared by distillation (without boiling) and then boiling the sample for a few hours. Each sample has its own 'freezing point' which it keeps within 0.1°C for, at least, a few months. The pressure, up to 100 atmospheres, does not affect the 'freezing point', but crystalline dust is not more active in this respect than amorphous dust. For initial temperatures below -10°C a long chamber was used. In such cases the ice particles which are formed high in the chamber grow sufficiently when falling to be observed in the beam of an arc lamp illuminating the bottom of the chamber.

It appears that ice particles formed in thoroughly clean air are formed by sublimation, and that sublimation phenomena due to adiabatic cooling differ essentially from phenomena of condensation since (a) the formation of ice particles seems to depend only on the minimum temperature reached after expansion, (b) even in thoroughly clean air they are formed at supersaturations which are far smaller than those necessary to form water droplets. These results would seem to have interesting applications to the formation of clouds in the higher atmosphere.

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Explanation of the Joshi Effect

THE interesting experiments of Joshi and co-workers, on what they call the new light effect, relate to the decrease of current flowing in the high-voltage exciting circuit of a Siemen's ozonizer, when radiations fall on the chlorine gas contained within the ozonizer. Alternating voltages of the order of 10 kV. are applied between the inside and outside walls of the ozonizer and the current is measured, its order of magnitude being about 50 microamperes. The experimental arrangement and the description of the effect are given in recent papers by Deo¹ and Joshi².

An explanation of this effect seems to be possible from the quantum-mechanical dispersion formula of Kramers, namely

$$n^2 - 1 = 8\pi B \sum_{l,l'} \frac{\nu(l,l) |p_0^E(l,l)|^2}{h[\nu(l,l)^2 - \nu_0^2]} e^{-W_0/kT},$$

where $B = \frac{N}{\sum_l e^{-W_0/kT}}$, n is the refractive index of

the gas for the incident light, and ν_0 is the frequency of the atom or molecule corresponding to a transition from an energy-level $E(l)$ of quantum number l to the level $E(l')$ of quantum number l'

$$\nu = \frac{E(l') - E(l)}{h}$$

ν is negative if transition takes place from an excited level to a normal level. p_0^E are the unperturbed matrix elements of the components of the electric vector E of the primary beam.

The formula shows that in an excited gas, the refractive index should be less than that for the normal unexcited gas, due to the negative terms in the formula for the excited states. This expectation was experimentally established by Ladenburgh³ in neon. The equation applies to our case if we put ($n^2 = k$) the dielectric constant and ν_0 is the frequency of the electrical circuit, say, 50 cycles/sec. Hence when radiations fall on the chlorine gas, exciting it to higher vibrational and electronic states, the dielectric constant decreases and so does the dielectric current in the electrical circuit, which is essentially a condenser circuit, the plates of the condenser being the two electrodes of the ozonizer.

That our interpretation is not far from truth can be seen from the following considerations.

1. As the current is only of the order of 50 microamperes, for voltages of the order of 10 kV, it shows that it is mostly a dielectric current and not the ordinary ohmic conduction current. For a discharge current the magnitude would be of the order of one milliampere⁴. As a matter of fact, Joshi says in one of his papers that when experimental conditions were such as to get a faint glow in the gas, the light effect decreased. This was due to the conduction part of the current having been increased, with the consequent decrease of the change of dielectric current with radiation, as percentage of the total current.

2. The effect is a maximum in white and violet light compared to that for lower frequencies, whereas chlorine has its maximum absorption in the former. This corresponds to increase of magnitude and the number of the negative dispersion terms. Both these effects make the relative change of current bigger numerically.

3. The maximum of the effect occurs, on the whole, in regions of lower voltages, because the lower the

voltage the more is the current of dielectric or displacement nature

4 The maximum of the effect occurs at some range of pressures, neither too high (atmospheric) nor too low. At higher pressures, though the number of molecules is higher, the life and hence the relative number of the excited states will be lower on account of greater loss by collisions. Again, with decrease of pressure, the magnitude of the discharge current would increase, making $\Delta\epsilon/\epsilon$ numerically small. A compromise of all these factors leads to an optimum pressure (of the order of 50 cm. mercury) for particular experimental conditions.

An indirect experimental confirmation of our interpretation is the fact that the dielectric constant of ionized gases is less than unity. An excited molecule and an ionized molecule are different stages in the same direction. There may be other minor points associated with the effect, having different causes, for example, the influence of walls of the ozonizer on $\Delta\epsilon/\epsilon$, etc., but for the main fact of decrease of current with irradiation the effect of negative dispersion terms seems to be the right cause.

A possible weakness in our interpretation is that the intensity of the excited states is usually regarded as small as compared to the normal state.

Fuller details will be published later on

R. PARSHAD

Physics Laboratory,
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Jan 15

¹ Deo, P. G., *Ind. J. Phys.*, **18**, 84 (1944)

² Joshi, *Nature*, **154**, 147 (1944)

³ Ladenburgh, *Rev. Mod. Phys.*, **5**, 243 (1933)

⁴ Glockler and Lind, "Electrochemistry of Gases and other Dielectrics" (John Wiley and Sons)

'Anomalous' Behaviour of the F_2 Region of the Ionosphere

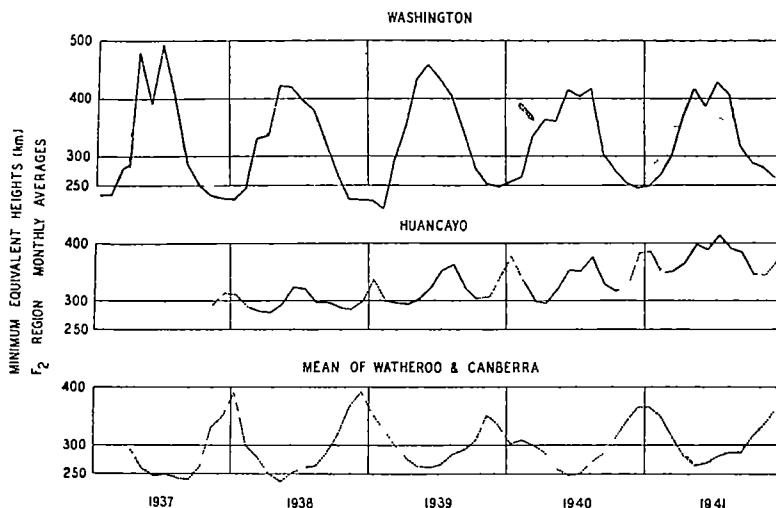
It has been known for some years that the seasonal and diurnal variations, and the geographical distribution of the maximum electron density N in the F_2 layer, the main observable region of the ionosphere, are anomalous in that they do not conform to the simple Chapman theory of ionization production, according to which N should be proportional to $\cos \chi^{1/2}$, where χ is the zenith distance of the sun. For example, in temperate and high latitudes in the northern hemisphere, the noon values of N show a minimum in mid-summer and a maximum in mid-winter, a variation which is exactly out of phase with theory, while in the southern hemisphere in temperate latitudes noon N exhibits maxima near the equinoxes and minima in mid-summer and mid-winter.

Two theories usually are jointly invoked to explain these and other similar anomalies. According to the first, the low values of N in mid-summer are due to a great expansion of the upper atmosphere by solar heating. On the Chapman theory, N is proportional to $T^{-1/2}$, so that such heating, if great enough, might explain the lowering of noon

N in mid-summer. This view appears to be supported by the fact that h' (max.), the height at which N is found, is some 150 km. greater in summer than in winter. The second theory explains the different type of variation in the northern and southern hemisphere as due to a superposed annual variation of ionization, of unknown origin, which has a maximum throughout the world in December-January and a minimum in June-July. Simple calculation shows that the expansion theory demands a summer value for T of the order ten times greater than the winter value, which is highly improbable on any reasonable theory of radiative equilibrium in the ionosphere, so that it seems desirable to explore other possible explanations of F_2 region anomalies. Evidence in support of an alternative theory is supplied by the data shown in the accompanying graph, which compares the monthly mean minimum equivalent heights h' for north temperate, south temperate and equatorial locations for the period 1937-41. The locations are, respectively, Washington, D.C., the mean of Watheroo and Canberra (Australia) and Huancayo (Peru). The data used were taken from that published regularly in *Terrestrial Magnetism and Atmospheric Electricity* during these years, together with the unpublished records taken at the Commonwealth Solar Observatory, Canberra. The Huancayo graph is drawn as a dotted line when the sun is to the south.

It will be seen from the graphs that the height variations in the northern and southern hemisphere are out of phase, showing a true seasonal variation, with maxima in mid-summer, as the 'heating' theory would predict. On the other hand, it is seen that h' at Huancayo does not show maxima when the sun is overhead (that is, in February and October), in disagreement with this theory. Inspection shows, however, that the Huancayo graph parallels that of Washington when the sun is north of Huancayo and parallels that for Australia when it is in the south. (The more complex graphs for N at the same stations, which are not reproduced here, show the same phenomenon.) This behaviour, which is similar to that of the diurnal variation of the magnetic declination at Huancayo, suggests strongly that the variations of h' and N are controlled, as are the magnetic variations, by large-scale tidal movements in the upper air.

Evidence for the existence of such a tide at these levels is presented in a separate communication. The



different seasonal behaviour of N in the two hemispheres is believed to be due to a difference in the seasonal variation of the phase of the tides in the two hemispheres

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Magnetic Properties of some Paramagnetic Crystals at Low Temperatures

MEASUREMENTS have been made on the principal magnetic susceptibilities of single crystals of a large number of paramagnetic salts of the iron group, from room temperature down to about 80° K. A detailed discussion of the results on the basis of the crystalline field theory will shortly be published elsewhere. According to this theory, the deviations from the simple behaviour to be expected of the free ions are attributed to the Stark splitting of the energy-levels of the paramagnetic ion under the influence of the strong and generally asymmetric electric field that occurs in the neighbourhood of the paramagnetic ions in these crystals, due to the negatively charged atoms that surround these ions. The following are some of the main results obtained.

In manganous and ferric salts in which the paramagnetic ion is in the S -state, the anisotropies are negligibly small, and the temperature variation of the susceptibility almost exactly follows the Curie law $\chi = C/T$.

In chromic salts also this is so, even though the Cr^{+++} ion is not in the S -state. This is due to the fact that the lowest level in the Stark pattern of Cr^{+++} is a singlet, and it is widely separated from the upper levels, the singlet level, however, has a $(2s + 1)$ -fold spin-degeneracy.

The nickel salts are very similar to the chromic salts in their magnetic behaviour, except that the spin-orbit coupling in Ni^{++} is much greater than in Cr^{+++} , and this conduces to a much larger deviation from the S -state behaviour than in Cr^{+++} , in other words, it leads to an appreciable magnetic anisotropy and deviation from the Curie law. These deviations are utilized to calculate the crystal field constants, and it is found that not only the cubic part of the field which is predominant, but even the rhombic part which is small, is nearly the same in most of the nickel salts, and they are practically independent of temperature.

In both Co^{++} and Fe^{++} salts, owing to the ground-level being a triplet, the magnetic properties are more sensitive to the rhombic part of the field than in the nickel salts. An estimate has been made of the rhombic part of the field.

The copper salts, as judged by their magnetic properties, fall into three distinct classes. In the first class all the principal susceptibilities follow the Curie law, but with different Curie constants, that is, the effective moments are different for different directions, but all of them are practically independent of temperature. To this class belong the Tutton salts. In the second class the principal moments are nearly the same as before, but they all decrease with the lowering of temperature, slowly at first and rapidly at later stages. The double chloride of copper and ammonium is a typical example of this class. To the third class belongs cupric acetate monohydrate,

in which the principal moments are all very low even at room temperature and decrease rapidly as the temperature is lowered. The three classes correspond to the non-cubic part of the crystalline field, being very different, lowest in the first class and highest in the third.

The influence of covalent binding on the strength of the electric field, and ultimately on the breaking of the Russell-Saunders coupling not only between the spin and orbital moments, but also between the spins of the different electrons of the ion, and its effect on the magnetic properties of the ion, have been discussed.

Though in the majority of the crystals the magnetic axes do not change their directions in the range of temperatures studied, the change is appreciable in some crystals, the largest change observed being 7°.

There is an axis of magnetic symmetry in nickel and ferrous salts, even though the crystal structure does not lead to it.

My thanks are due to Prof K S Krishnan for his interest in this work, and to the Indian Association for the Cultivation of Science, Calcutta, for facilities for carrying out the experiments.

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Theory of Viscosity of Concentrated Suspensions

FOR infinitely diluted suspensions of rigid spheres, Einstein¹ derived on a rigorously theoretical basis the formula

$$\eta = \eta_0 (1 + kc), \quad (1)$$

where η is the viscosity of the suspension, η_0 is the viscosity of the pure solvent, c is the concentration by volume and $k = 2.5$ is a constant. It has been shown that (1) is also valid for non-spherical particles, the factor k being a function of their shape, rigidity and Brownian movement. For elongated rigid particles, $k > 2.5$.

If it is assumed that the suspension behaves hydrodynamically with respect to an additional particle as a homogeneous medium, it is possible to derive a theoretical viscosity formula for higher concentrations. Let us add a particle of a volume dV to a suspension of viscosity η , containing already a volume V of similar particles in a volume A of the pure liquid. Then the increase of the viscosity should be

$$\eta + d\eta = \eta \left(1 + k \frac{dV}{A + V} \right), \quad (2)$$

or after a slight rearrangement

$$\frac{d\eta}{\eta} = k \frac{dV}{A + V}, \quad (3)$$

which can be easily integrated, giving

$$\eta = \eta_0 (1 + V/A)^k = \eta_0 (1 - c)^{-k} \quad (4)$$

If $c = 0$, $\eta = \eta_0$, so that the integration constant η_0 is the viscosity of the pure liquid.

The assumption of hydrodynamical homogeneity of the suspension holds only if the particles are sufficiently far apart, so that their mutual interactions other than a general increase of viscosity are neglig-

ible However, under the shearing motion of the liquid the particles move relative to each other and collisions occur These do not resemble collisions in a gas, the particles rolling round each other, until they reach such positions that a disengagement through further shear takes place

It can be shown for suspensions of rigid spheres that each sphere is in collision for an average fraction of time proportional to the concentration c During this time the colliding pair increases the viscosity more than a separated pair, due to a combination of several effects The most important effect is caused by a certain volume of liquid being immobilized around the point of contact This volume is proportional to the volume of the spheres The total immobilized volume qVc , where q is a proportionality constant, should be thus subtracted from A and added to V in equation (4) Whence

$$\eta = \eta_0 [1 + (V + qVc)/(A - qVc)]^k = \eta_0 (1 - c - qc^2)^{-k} \quad (5)$$

The constant q was calculated by an approximate method to be not far from unity for rigid spheres, and it is expected to be much less, if the spheres are soft, as there will be less liquid immobilized around the point of contact The shape factor k should also change slightly with concentration, as two colliding spheres behave as one non-spherical particle, but this effect is negligible compared with the effect of the immobilized liquid

As there are no accurate viscosity data available for concentrated suspensions of rigid spheres, measurements of Erich, Bunzl and Margaretha² extending only up to about 20 per cent, measurements of suspensions of glass spheres were made to test the formula (5) The glass spheres of 0.013 cm. diameter

were kindly loaned by Dr F Erich, being the same as those in his investigations. The spheres were suspended in a saturated solution of zinc iodide in water and glycerine which has the same density as glass and a high viscosity of 80 centipoises at 20° C., this made corrections for inertia effects of the spheres unnecessary

Measurements were made in two Ostwald viscometers, having diameters of the capillary 0.23 cm and 0.38 cm, and in a Couette apparatus with diameter of the inside cylinder 1.264 cm, of the outside cylinder 3.6 cm The uncorrected measurements from different viscometers were in disagreement with each other, but after being corrected for the wall effects they agreed surprisingly well, as can be seen from the accompanying graph, where the corrected results from different instruments are plotted against concentration The full curve represents formula (5) with values of $k = 2.5$ and $q = 1.16$, which are the values fitting best the measurements The agreement of the measurements with the formula (5) is well within the experimental error up to a concentration of 37 per cent

Above this concentration, suspensions subjected to shear are no longer isotropic and exhibit different viscosities in different directions, the rate of shear ceases to be proportional to the shearing stress and depends on the previous history of shears

I wish to express my thanks to Dr F Erich for the loan of the spheres Detailed results will be reported elsewhere

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¹ Einstein, A, *Ann Phys*, iv, 19, 289 (1906), 34, 591 (1911)

² Erich, F, Bunzl and Margaretha, *Koll.-Z.*, 74, 276 (1936)

Fluidity and Molecular Structure

It was pointed out by Porter¹ that, for mercury and water, the logarithm of the viscosity is a linear function of the logarithm of the vapour pressure I propose a modified relationship introducing the critical pressure p_c , namely,

$$\log \phi = a \log p/p_c + d,$$

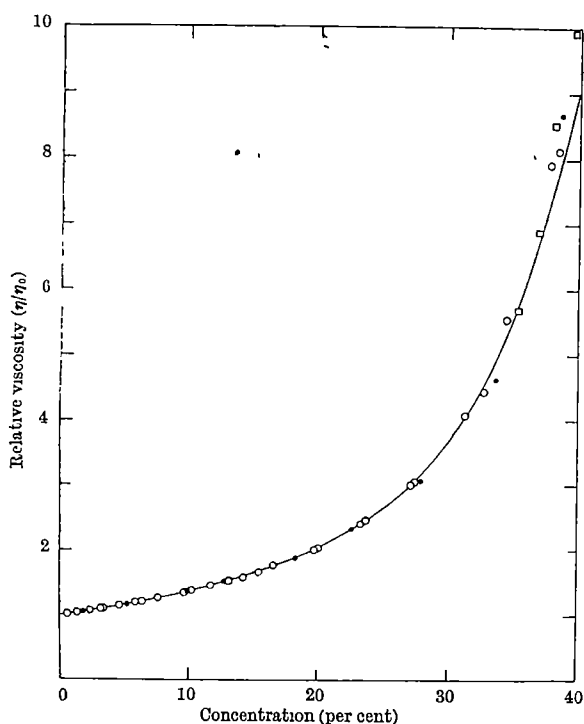
where ϕ is the fluidity of a liquid at the vapour pressure p , a and d are constants

Putting $p = p_c$, then $d = \log \phi_c$, and we can write

$$\log \phi/\phi_c = a \log p/p_c \text{ or } \phi/\phi_c = (p/p_c)^a \quad (1)$$

It has been found that, with the exception of associated substances, and apparently a small number of liquids possessing highly symmetrical molecules, a does not differ greatly from the mean value of 0.24 for all pure compounds examined Equation (1) expresses an interesting extension of the theory of corresponding states, for it implies that, at the same reduced pressure, non-associated liquids have nearly the same reduced fluidities Furthermore, as a rough approximation, such liquids possess the same value of $d = \log \phi_c$, and so the fluidity or viscosity of a substance depends primarily on its 'distance' from the critical state

In the simple Porter equation, $\log \phi = a \log p + b$, b is the value of $\log \phi$ at some arbitrary unit pressure, for example, expressing p in standard atmosphere



RELATIVE VISCOSITY OF SUSPENSIONS OF GLASS SPHERES AS A FUNCTION OF CONCENTRATION BY VOLUME

Ostwald viscometer measurements, capillary diameter 0.23 cm, ●, capillary diameter 0.38 cm, ○, Couette viscometer measurements, □ Theoretical curve calculated from the formula (5) with $k = 2.5$, $q = 1.16$, full line

units, b becomes $\log \varphi_B$, the logarithm of the fluidity at the boiling point under 760 mm of mercury pressure

For substances examined having a approximately 0.24, it has been found that the function $M \log \varphi_B$, where M is the molecular weight, can be evaluated from a list of atomic and structural constants, and the fluidity of a given non-associated liquid at its boiling point be calculated with an average error of 3 per cent

Work on these lines is now in progress together with an examination of the above relationships as applied to liquid solutions. Full details will be published as soon as possible

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Feb 5

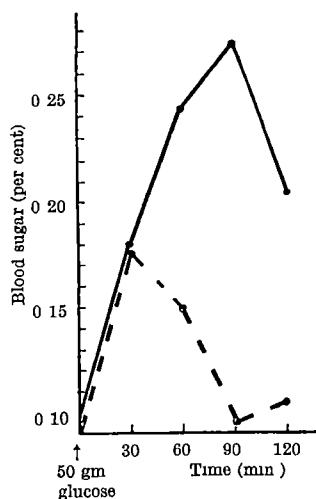
¹ *Phil Mag*, 23, 458 (1912)

Effect of Electrically Induced Convulsions on the Sugar Tolerance of Psychotic Patients

IN this Hospital, investigations are being made on the sugar tolerance curves of a number of psychotic patients. Abnormal curves in such patients have been found by workers in the past^{1,2}

As progress is comparatively rapid during electric convulsion therapy, it was felt that possible changes in these curves during treatment might be present and this was in fact found to be so. Patients suffering from depressive and manic depressive insanity show the greatest abnormality in their sugar tolerance and also the greatest change in this during treatment. The typical curve before treatment is shown in the accompanying graph. The fasting level is normal or slightly raised, there is a rapid rise to heights well above physiological limits followed by a sharp descent, but not reaching the original level in two hours.

After two to six convulsions, although the mental condition improves, the curves show increasing



SUGAR TOLERANCE CURVE
Full line, patients broken line, average normal

abnormality. Thus, in most cases the fasting level is raised and the maximum reached in half or one hour is in the region of 0.4 gm per cent. Gradually, after the mental condition has been normal for many weeks, the curves become normal too.

In all cases of depression the first effects of electric convulsion therapy on the sugar-tolerance curve is to raise both the fasting level and the maximum.

This profound physiological disturbance described above is of great significance since it shows, at least for some mental disorders, a relationship between metabolism and the so-called functional disorders.

This investigation is being continued.

A. GLYNN

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Jan 23

¹ Drury and Farren Ridge, *J Mental Sci* (1925)

² Mann, S. A., *J Mental Sci* (1925)

Oestrogenic Substances showing Anti-tumour Action

CONTRARY to the general impression (due to publications attributing carcinogenic properties to oestrogens when administered to both sexes of different animals, also the oestrogenic activity, although notably weak, of many carcinogens), I have during my researches^{1,2} on oestrogens come to believe that these compounds are not carcinogenic, and that they will most probably show at least some curative influence in the case of tumour diseases. I submitted a detailed report on "Oestrogens as Anti-tumour Compounds" to the Ministry of Public Health in Egypt on May 30, 1944. An account of the influence of synthetic oestrogens upon advanced malignant disease was recently published³.

Owing to the remarkably prolonged action of α -di-(*p*-ethoxyphenyl)- β -phenylbromoethylene^{4,5} when given orally, and its remarkably low toxicity, if any⁶, it was proposed to use this substance in the treatment of ovarian tumours and cancer of breast. The following describes its influence in two cases of cancer.

Case 1 A patient fifty-seven years old was operated on for breast cancer, the right mammary gland being removed. Seventeen months later recurrence with metastases in the liver was noted. Within the next eight weeks the patient became much worse, became dumb, the faeces became colourless apparently indicating biliary obstruction, and oedema developed in both legs and in the right arm. On July 3, 1943, a 100-mgm cachet of α -di-(*p*-ethoxyphenyl)- β -phenylbromoethylene was given to the patient, and on the following three days, a 250-mgm cachet was given daily. The oedema completely disappeared within five days from the beginning of the treatment, the faeces resumed the normal colour and the patient spoke once. The patient, however, died on July 10, 1943.

Case 2 A patient aged forty-five suffering from sarcoma ovarialis of a comparatively large size had the abdomen opened in the King's Hospital, Cairo on July 31, 1943, and the tumour being inoperable was left untouched. The tumour continued to increase in size, filling the abdomen and pressing against the different abdominal organs. Treatment with α -di-(*p*-ethoxyphenyl)- β -phenylbromoethylene began on August 23, 1944, the oestrogen being administered

orally (6-8 gm. monthly, in 200-mgm. cachets, once, twice or thrice daily with intermittent intervals of 2-3 days every 3-5 days). A considerable improvement took place. Dr. Hamed Mohamed El Dewany, the private physician of this patient, states: "the patient suffered from sarcoma ovarialis. Surgeons and radiotherapists, who were consulted, considered the case hopeless. With the administration of α -di-(*p*-ethoxyphenyl)- β -phenylbromoethylene proposed by Dr. Wadie Tadros, the tumour softened and decreased in size, and the patient was relieved from pain". The tumour, although at a slower rate, is at present continually regressing.

It is remarkable to note the drop of temperature almost to normal within 3-4 days after the administration of α -di-(*p*-ethoxyphenyl)- β -phenylbromoethylene to cancer patients with temperature above normal. When tested *in vitro*, however, it was reported⁷ that it had no anti-bacterial action.

Robson and Ansari⁸ noted that the fate of this substance was, in some respects, very different from that of the oestrogens so far studied. Unlike the natural oestrogens, which are rapidly inactivated (chiefly by the liver), and stilboestrol, which is rapidly eliminated from the body after absorption, it is stored in the body tissues to an appreciable extent and is eliminated comparatively slowly.

Although the administration of oestrogens in attempting to treat malignant diseases gave in many cases beneficial effects, it is to be noted that in dealing with the problem of these diseases, many factors, apparently interrelated, have to be taken into consideration. Among these may be mentioned the anaemia prior to or after the development of the malignant disease, secondary infections, degree of malignancy and toxæmia due to necrosis of tumour tissues. Moreover, it seems likely that controlled application of both radio- and oestrogenic-therapy may sometimes be desirable rather than the administration of high overdosage of the oestrogen alone, provided that other factors such as anaemia, toxæmia, etc., referred to above, can be dealt with. Prophylactic implantation of oestrogens following surgical and radium castration has been reported⁹.

The application of α -di-(*p*-ethoxyphenyl)- β -phenylbromoethylene in an attempt to treat different types of malignant diseases is in progress in collaboration with different medical investigators, and results will be published when sufficient data are available. In the meantime, I am continuing investigations on the synthesis of more highly active oestrogenic compounds with greater anti-tumour effect.

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Dec. 17.

¹ Schönberg, A., Robson, J. M., Tadros, Wadie, and (in part) Fahim, H. A., *J. Chem. Soc.*, 1327 (1940).

² Tadros, Wadie, *Nature*, 148, 53 (1941).

³ Haddow, Alexander, Watkinson, Jean M., Paterson, Edith, with an addendum by Koller, P. C., *Brit. Med. J.*, p. 393 (Sept. 23, 1944).

⁴ Robson, J. M., Schönberg, A., and Tadros, Wadie, *Nature*, 150, 22 (1942); the name of the third author was inadvertently omitted in this publication.

⁵ Tadros, Wadie, and Schönberg, A., *J. Chem. Soc.*, 394 (1943).

⁶ This information was noted in a letter received from Dr. J. M. Robson, University of Edinburgh.

⁷ Faulkner, G. H., *Lancet*, 38 (1943).

⁸ Robson, J. M., and Ansari, M. Y., *J. Pharm. Exp. Ther.*, 79, 344 (1943).

⁹ Geist, G. H., Walter, R. I., and Salmon, U. J., *J. Mount Sinai Hosp.*, 8, 543 (1942).

Foot Rot (*Phoma* sp.) of Flax

Foot rot disease of flax caused by a species of *Phoma* was first recorded in Ireland by Pethybridge *et al.*¹ in 1921. Since then it has been noted to occur consistently in the Northern Ireland crop although the responsible species of the parasite still awaits identification. A review of the literature indicates that *Phoma* has been reported as attacking the flax crop on the Continent of Europe since the 1890's, and, more recently, in Australia², the causal organism being variously referred to as *P. exigua*, *P. herbarum* and *P. linicola*.

Foot rot first becomes readily noticeable during mid-season when odd plants here and there in the crop show a wilted appearance. On pulling affected plants, pycnidia of *Phoma* will normally be found to occur in profusion along the basal portions of the stems (see photo.). The plants die prematurely and turn brown while the remainder of the crop is still green. Although foot rot is the phase usually encountered, the fungus can attack and kill the plants in the seedling stages (see photo.); the nature of the attack and the symptoms produced are largely determined by seasonal growth conditions.

The disease may be found if searched for in almost any season, but, until 1944, it was seldom found attacking more than a few straws in any crop, and it was for this reason that Pethybridge and Lafferty included it in the group of less important flax straw diseases referred to collectively as causing 'dead stalks' in the crop. That the disease may be of a serious nature and of epidemic importance was revealed in 1944 when some crops in Northern Ireland, Scotland and Wales were seriously affected; this epidemic outbreak was quite unexpected and, until then, no such cases had been recorded.

The pathogenicity of *Phoma* towards flax is well known, and has been confirmed by our experiments. Until now, however, it has been generally assumed that the parasite is normally soil-borne and that infection is most likely to occur through the medium of the soil. This may be so, but evidence accumulated during the past few years shows that the parasite may be seed-borne and indicates that the seed may be a more effective means for transmission than the soil. Seed produced in the more northerly and westerly parts of the United Kingdom is much more likely to be contaminated with the parasite than that produced in the south and east. This is due, no doubt, to climatic conditions and to the greater difficulty of harvesting non-weathered crops in the north and west. There is also a tendency towards a building up of seed contamination when seed is successively saved from crops grown in areas liable to favour the incidence of the disease and when a succession of poor seasons is experienced. It has been found possible to use the Ulster method³ for determining the extent of seed contamination and this has proved most useful in the separation of clean from contaminated seed.

The fact that the parasite may be seed-borne raises the question of the efficacy of seed disinfection in clearing it from a seed sample. Using the same technique as that devised for *Colletotrichum linicola* and *Polyspora lini*⁴, we have carried out a large number of laboratory tests with the following results. 'Nomersan' (10 per cent tetra-methyl-thiuram disulphide), which has proved effective for the control of *C. linicola* and *P. lini*^{5,6}, did not give very satisfactory results in the case of *Phoma*; repeated trials indicate it to be about 50 per cent effective when



LEFT, FLAX STEM ($\times 6$) SHOWING PYCNIDIA OF *Phoma* SP.;
RIGHT, FLAX SEEDLINGS ATTACKED BY *Phoma* SP.

used at the rate of 12 oz. per cwt. of seed. The short wet method of seed treatment using an 8 per cent solution of 'Ceresan U.564' at 0.9 gall. per cwt., although more effective than treatment with 'Nomersan', still did not provide adequate control. Further trials have been made using 'Arasan' (50 per cent tetra-methyl-thiuram disulphide), 'New Improved Ceresan' (5 per cent ethyl-mercury-phosphate), 'Fermate' (ferric dimethyldithiocarbamate) and 'Spergon' (98 per cent tetrachloro-*para*-benzoquinone). Of these materials promising results have been given by 'New Improved Ceresan' and 'Arasan'. Using 'New Improved Ceresan' at the rates of 12 oz. and 9 oz. per cwt. of seed, the contamination of a seed sample was reduced from 32.6 to 2.0 per cent and 5.5 per cent respectively. 'Arasan' used at the same rates reduced contamination to 10.8 per cent and 14.5 per cent. In the case of 'Arasan' it is of interest to note that the duration of the test had to be extended from seven to twelve days as this disinfectant exerts an inhibiting effect upon the fungus. No such effect was noted in the case of 'New Improved Ceresan' which appears to be more directly toxic. Whereas 'New Improved Ceresan' showed generally powerful fungicidal and bactericidal activity, the same selectivity was noted in the case of 'Arasan' as with other disinfectants with tetra-methyl-thiuram disulphide as the active constituent; in the case of bacteria and some fungi these materials have little or no effect.

Although it has not yet been possible to arrange for field trials with these materials, the high degree of correlation obtained between the results from laboratory and field trials in the case of *C. linicola* and *P. lini*⁷ suggest that results obtained in the laboratory should also be closely applicable in the field in the case of *Phoma*. It is proposed to adopt the use of both 'Arasan' and 'New Improved Ceresan' on a commercial scale during 1945. Of all the disinfectants tested for flax, 'New Improved Ceresan' offers the greatest promise for seed-borne diseases generally, its only drawback being its poisonous nature when compared with 'Arasan' and 'Nomersan'.

Tests made with samples of seed treated with 'Arasan' or 'New Improved Ceresan' at the rate of 12 oz. per cwt. have shown that such treatment has no effect upon germination. No adverse effects upon germination have been observed after treated seed

has been stored for eight weeks either in small packets in the laboratory or in hundredweight lots subject to ordinary storage conditions. In all cases the moisture content of the seed used was below 10 per cent.

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¹ Pethybridge, G. H., Lafferty, H. A., and Rhynehart, J. G., *J. Dept. Agric. Irel.*, **21**, 167 (1921).

² Millikan, C. R., *J. Austral. Inst. Agric. Sci.*, **10**, 129 (1944).

³ Muskett, A. E., and Malone, J., *Ann. Appl. Biol.*, **28**, 8 (1941).

⁴ Muskett, A. E., and Colhoun, J., *Ann. Appl. Biol.*, **30**, 7 (1943).

⁵ Muskett, A. E., and Colhoun, J., *Nature*, **146**, 32 (1940).

⁶ Muskett, A. E. and Colhoun, J., *Nature*, **147**, 176 (1941).

⁷ Muskett, A. E., and Colhoun, J., *Ann. Bot.*, (N.S.), **6**, 219 (1942).

A Method of Estimating the Activity of Spermatozoa

IN view of the absence of any satisfactory method for the quantitative estimation of the motility of spermatozoa, it is believed that the following method, evolved in relation to work on human semen, may prove of interest.

The semen is diluted with warm phosphate-glucose solution¹ (one in twenty gives a satisfactory dilution for semen containing 70–200 million sperm per c.c.). The dilution is thoroughly mixed by bubbling air through it with a pipette. One drop of fluid is placed on each of two Thoma counting slides. Over one drop is inverted a small straight-sided glass capsule lined with filter paper moistened with 2 per cent osmic acid. The osmic vapour permanently immobilizes all the sperm in about ten seconds. The capsule is removed, and cover slips are placed on both drops, taking the usual precautions to avoid running over. If the capsule is kept upside down on a glass plate, one drop of osmic acid will last about six hours.

The slides are put aside to allow the sperm to settle, that with the motile sperm being placed on a warmed microscope stage. After five minutes this slide is examined and a count made of the immobile, and of the feebly moving but non-progressive sperm in 160 small squares. The two figures thus obtained may be stated as x and y respectively. The actively moving sperm are ignored. A count is then made on the osmicated slide of all the sperm in 160 small squares, giving a figure z . Subtraction of $x + y$ from z gives the number of active sperm in the suspension corresponding to a total number of sperm z , and a volume of fluid contained in 160 small squares.

Sperm which have been cold for an hour or longer do not all become active immediately when mixed with warm diluting fluid, and maximum motility may not be reached until the dilution has been kept at 37° C. for an hour.

When repeated estimations of motility are required during the course of an experiment, it is essential to take two drops for comparison each time, as clumping or disintegration may cause a progressive reduction in the total number of sperm in the suspension.

This work has been assisted by a research grant from the Family Planning Association.

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¹ Chang, M., and Walton, A., *Proc. Roy. Soc.*, B, **129**, 517 (1940).

MEAT IN GREAT BRITAIN

THE British consumer recognizes very clearly that war conditions have brought about marked changes in the kind as well as the quantity of meats we eat. The British farmer realizes the changes that have taken place under war controls in the methods of marketing the meat products of his farm. The former may long for the freer choice of kind, quality and price of pre-war times, the latter may wonder how far the present marketing systems foreshadow post-war schemes. Both are in doubt as to the supplies which may be available, and probably neither completely comprehends the broad complexity of the home supply-distribution situation, as it affects the home-market position. Moreover, meat is, in normal times, a foodstuff in which individual preferences for quality, as well as of purpose and price, are allowed wide play. The pie or the pot, the stew or the roast, an 'r' or no 'r' in the month—while such preferences can be signs of the housewife's whim, or her purse, they can also be factors affecting supply and distribution.

At a meeting of the British Society of Animal Production, held on February 21, the meat situation in Great Britain was reviewed from three main aspects, the leading papers being on supplies, by Major W. H. Warman and Mr. R. W. Pomeroy, on carcass quality and grading, by Dr. E. H. Callow, and on the marketing and distribution of home-produced meat and livestock, by Mr. T. J. Shaw.

Before the War, Great Britain consumed, in addition to her own production, about 90-95 per cent of the world's exported surplus of meat. Advances in processing techniques have given us chilled, frozen, boned and canned meats. Whatever the country of origin of the imported meat, its production, processing, grading, transport and distribution were organized towards meeting fairly specific consumer demands, which formed only part of the home-consumption market. In contrast, British home production was all absorbed here in its wide variety of kinds, weights, qualities and prices. Again, owing to, or coincident with, the canalization of the whole industry in exporting countries, the treatment and utilization of edible and inedible offals have become highly developed and contribute to the efficiency and economy of the processing system. In contrast there were, before the War, just over 16½ thousand slaughterhouses, private and municipal, handling roughly 17½ million carcasses which formed the home supply of Great Britain. Further, within Great Britain we have fairly well defined importing and exporting areas, for example, the populous conurbations, as against Scotland and the south-west of England, respectively. So far as stock movements are concerned, there were frequent changes in ownership, not necessarily connected with changes in the condition of the stock, for example, store stock could change hands several times as stores, and partly fattened animals pass from one owner to another without progressing much towards the 'finished' slaughter stage. Also, the question of the effect of movement of fat stock on the quality of the carcass still needs investigation, for the best results and the most efficient supply service, should finished stock be slaughtered in the producing areas or in the consumption areas?

In relation to consumer's preferences the general trends up to 1939 were towards youth rather than to age, to tenderness rather than flavour, and to

lighter weights rather than large cuts. Geographical variations complicated the situation, thus while the Midlands and the north preferred large pork and bacon carcasses, London and the south favoured pork of about 60-80 lb weight. Moreover, even with the wide use of feeding-stuffs imported from overseas, there were marked seasonal fluctuations in the kinds of meat produced here: stall-fed winter beef, autumn grass-fed beef, lamb from the arable flocks of the south in spring, hill lambs and ewe mutton later in the year, and older lambs bred on the hills but fattened on root grounds still later, and on into the first months of the year. Also, in spite of these trends we consumed—we had to, though Lancashire liked to—considerable quantities of cow beef, thereby absorbing the high wastage in our milk-producing herds.

War economy has imposed severe changes on this general structure. The emphasis is on quantity—weight rather than quality. The exclusion of imported feeding-stuffs has placed reliance on home-grown fodders, and revealed a 10 per cent fluctuation in autumn weights between good grazing seasons and bad. Fat stock pass into control at local collecting centres at which the basis of payment is fixed according to grading schedules. Local consumption, apart from supplies originating overseas, is closely related to local production.

The results of these measures of control were soon manifest in all classes of meat, but in one respect the harvest is still to appear—the emphasis on dairy stock which attends the priority given to milk production is judged to lead, with herd wastage still high, to a relative increase in the beasts with inferior capacity to give good beef. Yet nuclei of good beef-breeding types remain, and our presently diminished pig and sheep stocks still contain those types upon which, by appropriate use and from suitable combinations in cross-breeding, the British meat-producing industry could be rebuilt in its multiplicity of kinds and qualities.

If the post-war rehabilitation and form of the meat-producing industry of Britain are to be grossly influenced by the use of imported feeding-stuffs, the questions of available shipping and of available exchange will be prominent. Also, but by no means independent of these, there is the long-term trend for many of those countries which have in the past exported feeding-stuffs to prefer to convert those feeds to carcasses at home, and thus to export, for example, their cereal grains as meat, of higher cash value per unit weight. Behind all, there lie the possible and prospective changes in methods of production and local consumption and demand in the areas from which our meat imports were derived.

This review only touches upon some of the major topics which emerged in the general discussion, it may indicate how the problems are interlaced and the need for much further precise information. Fortunately, there has been a steady accumulation of data which tend to resolve the elusive problems of meat quality and to elucidate the relationships of growth, fattening and food values. In this direction, at least, the scientific principles on which the characteristics of the consumers' demands can be interpreted back to the producer are becoming revealed, and the exposition of the results of recent work in this field at the Low Temperature Research Station at Cambridge made a valuable contribution to the proceedings.

It is hoped that a full report will shortly be published by the Society.

J. E. NICHOLS

A COLTSFOOT PROBLEM

By RICHARD MORSE

SOME time ago, when I was carrying out some investigations concerning the behaviour of plants, I came across the statement, in Sir J. E. Smith's "English Flora" (1829), that the flowers of the coltsfoot (*Tussilago farfara*) are "drooping in the bud". The statement surprised me because, although I had been observing the behaviour of this plant fairly closely over a number of years, both in its wild state and under controlled conditions, I had never once seen it produce flower buds that could in any sense be called drooping. As it was inconceivable that the coltsfoot had changed its behaviour since 1829 I could only conclude that the great botanist was in error, and there the matter was allowed to rest.

Recently, however, I have had occasion to inquire into the subject again, and have been amazed at the number of authors who have, in one form or another, repeated Sir J. E. Smith's statement—a statement which I still believe to be wholly untenable.

In Richard Deakin's monumental "Florigraphia Britannica" (1847), for example, the coltsfoot is described as having "the bud drooping, erect when in flower". Yet Deakin was, presumably, a careful worker with an extensive knowledge of British plants, for we are assured in his fourth volume that the entire series of illustrations, numbering well over 1,600, "are accurate facsimiles engraved from original drawings, made by the Author from the Plants themselves, and carefully coloured after nature".

Again, in the third volume of the five which Anne Pratt devoted to "The Flowering Plants and Ferns of Great Britain" (1856), reference is made to "the drooping unexpanded flower-buds" of this plant, in Hooker's famous "Student's Flora" (1884) appear the words "drooping in bud"; in Johns' "Flowers of the Field" (1919) the phrase takes the form of "drooping before expansion", in Babington's "Manual of British Botany" (1922) the heads are spoken of as being "erect in blossom and seed, drooping before and after flowering", and in Macgregor Skene's "A Flower Book for the Pocket" (1935) occurs the similar statement that "the head droops in the bud and again after flowering".

The above books, it will be observed, cover the period 1829–1935, so that, during more than a hundred years, students of British botany have been asked to accept, in regard to one of our commonest native plants, a statement which, so far as my experience goes, has no foundation in fact, and yet which, so far as I know, has never been discussed or corrected—save for one brief reference that I myself made to it in a broadcast talk some years ago.

What makes the problem stranger still is the fact that several of the books I have mentioned have passed through more than one edition, without, so far as one can tell, any query being raised as to the correctness of the assertions made. Thus my quotations are taken from the second edition of Smith's "Flora", the third edition of Hooker's, the tenth of Babington's "Manual" (edited by A. J. Wilmott), and the thirty-fourth of Johns' "Flowers of the Field" (revised by G. S. Boulger).

Allusions to the coltsfoot's alleged habit of drooping its flower buds, moreover, are by no means confined to books of the more scientific *flora* type. They have crept also into our agricultural, educational and 'popular' botanical literature.

Thus in the Ministry of Agriculture's "Collected Leaflets on Weeds", second edition, 1923, we are told that "at first the flower heads droop, but when they open out they are erect", and H. C. Long, in his "Weeds of Arable Land" (1929), uses precisely the same words.

Similarly, Prof. F. Cavers, in his "Life Histories of Common Plants" (1913)—a book intended chiefly for student teachers—tells us that each flower head "at first droops, but later becomes straight", and in his more advanced work entitled "Botany for Matriculation", revised by L. C. Fox in 1931, those exact words are repeated.

In books of a less scientific character, written chiefly for the general public, the alleged drooping buds of the coltsfoot have been mentioned time and again, for although nutant flower buds are common enough in Nature, this particular story seems to have caught the popular imagination. In James Cundall's "Everyday Book of Natural History" (1866), for example, we read that "at first the flower bud is pendulous, and is thus protected from the rain, as soon, however, as the bloom is ready to unfold to the sun, the flower stalk becomes erect".

John J. Ward, in his "Life Histories of Familiar Plants" (1908), is even more explicit: "The coltsfoot," he says, "guards its pollen almost as a bird does its eggs. When at first the flower stem peeps above the soil, its head droops while the stem elongates. Then, suddenly, the head becomes erect and the florets are exposed."

Again, G. Clark Nuttall, in his fascinating seven-volume work entitled "Wild Flowers as they Grow" (1912), tells us that, in February, the coltsfoot's "hard, thick stem with drooping head pushes up through the earth", while Edward Step, in his "Spring Flowers of the Wild" (1927), says that "until the female florets are ready to open, the stem is bent, so that the head droops".

I must confess that I am much puzzled by the above and other similar references to what I believe to be a wholly fictitious phenomenon. At the time of writing I have no access to *floras* of a date earlier than Sir J. E. Smith's, so I am unable to say whether the belief in the coltsfoot's drooping flower buds goes back beyond his day or not.

Two possible explanations of the prevalence of the belief occur to me. One is that, after someone's original blunder, author has copied author through all these years without ever referring to the plant itself, and the other is that the closed fruit heads have been mistaken for unopened flower heads. The fruit heads 'do', of course, droop for a time after fertilization has taken place. They are, however, so markedly different in appearance from the flower buds that it seems almost incredible that even the veriest amateur could mistake one for the other.

But there is also, of course, the further possibility that my own observations of the plant are at fault. On that point, however, I must leave readers to judge for themselves.

Perhaps I should say, in conclusion, that the omission of several well-known *floras* from the above list must not be taken to mean that they have not been consulted, but simply that I have not yet found one that controverts the statement made by Sir J. E. Smith. There is no reference to the matter, for example, in Withering's "Arrangement of British Plants" (1830), or in Hooker and Arnott's "British Flora" (1850), or in Grindon's "British and Garden

Botany" (1864), or in Bentham's famous "Hand-book" (1924), or in Bonnier's "British Flora" (1925) or in any similar work to which I have access. Brimble, in his "Flowers in Britain" (1944), does not query Smith's statement, but, though he refers to the flower heads being "borne at the ends of thick, erect stalks with hairy bracts", he does not state that the flower buds droop. Furthermore, an illustration shows an erect flower bud.

THE BROAD TAPEWORMS OF MAN, CORMORANTS AND GULLS

J. B. DUGUID and E. M. Sheppard (*J. Path. and Bact.*, 56, 73, 1944). See also *Nature*, 154, 185, 1944) described their discovery of plerocercoids of a *Diphyllbothrium* tapeworm in freshwater trout and sticklebacks in a South Wales reservoir and their work on its life-history. M. D. Hickey and J. R. Harris (*Brit. Med. J.*, 310, Sept 2, 1944) also found *Diphyllbothrium* plerocercoids in trout in the Dublin area, and a *Diphyllbothrium* adult tapeworm in sea-gulls and cormorants there (see also M. D. Hickey, *Brit. Med. J.*, 482, Oct. 7, 1944, and K. Unsworth, *ibid.*, 385, Sept 16, 1944). K. Unsworth (*Ann. Trop. Med. and Parasit.*, 38, 213, 1944) has now published the results of his work on the life-history of the South Wales species.

Starting with a rat infested by Duguid and Sheppard, Unsworth was able to confirm the results obtained by them. He successfully infested the copepods *Cyclops strenuus* and *Diaptomus gracilis*, which Duguid and Sheppard also used, but found that the former was the best first intermediate host. The nauplius larva of *Cyclops* readily ate the coracidia, which were fully developed by the time that the later copepod stages were reached. After 16-20 days of development in *Cyclops*, which Unsworth describes, the *Cyclops* were fed to sticklebacks, in which plerocercoids were obtained, chiefly in cysts on the serous surface of the stomach, under the peritoneum and under the liver capsule. When these sticklebacks were fed to one pike, which is known to be a second intermediate host of *Diphyllbothrium latum* of man, one plerocercoid was obtained from the pike. When plerocercoids from both the infested sticklebacks and the pike were fed to puppies aged 2-3½ months, the adult tapeworm developed in the puppies, which passed eggs in their faeces. Coracidia from these eggs infested *Cyclops*. Unsworth makes the interesting and epidemiologically important suggestion that the overwhelming infestation of the trout in so large an expanse of water in South Wales (100 per cent) was due to the fact that the trout ate sticklebacks which had already infested themselves by eating infested copepods. He supports this suggestion by the observation that the commoner fish hosts which harbour plerocercoids of *Diphyllbothrium* species (for example, perch, pike, wall-eyed pike, trout and burbot) are all fish-eating species, while the less common fish hosts of these plerocercoids (for example, grayling and pollan) eat fish only at times. Unsworth was unable to identify the species of *Diphyllbothrium* with which he was dealing, because he obtained only the scolex and immature anterior segments of the adult from the puppies which he experimentally infested, but, from these, he concluded that the South Wales species studied

by him was too small to be *D. latum* of man. He was also able to infest puppies with plerocercoids sent to him by Hickey from the Dublin area, so that this Dublin species can apparently develop to maturity both in a mammal and in birds (gulls, herring gulls and cormorants). Unsworth concluded that the Irish species is not *Diphyllbothrium latum* of man. The immature stages are not, however, enough for the identification of species of *Diphyllbothrium*.

All these workers sent specimens of the adult tapeworms obtained by them to H. A. Baylis of the British Museum, who concludes (*Brit. Med. J.*, 386, Dec. 30, 1944) that all the tapeworms obtained from the gulls represented one species, and all those from the cormorants another. Comparison of the worms obtained from the experimental mammalian hosts by all the workers led Baylis to conclude that all the workers were dealing in their experiments with a single species, which is probably the old but little-known species *D. dendriticum* (Nitzsch, 1824). In experimental mammalian hosts this species showed slight differences from species found in gulls, probably because the mammal is an abnormal host.

The question raised in the *Lancet* (475, April 8, 1944) that the species found in South Wales might possibly be *D. latum* of man, which does occur in the west of Ireland (see below) and might possibly have been brought to Britain by Polish and Norwegian refugees, as it has been established endemically in North America by immigrants, would seem to have been negated by Baylis's decision. The whole question, however, requires further investigation, for T. E. Gibson (*Brit. Med. J.*, 200, Feb 10, 1945) records yet another infestation of trout in a Northamptonshire reservoir with plerocercoids morphologically similar to those described by Duguid and Sheppard. These failed to infest a guinea pig, but they did infest three rats, which finally threw off the infestation spontaneously, as Unsworth's puppies did. Gibson also found plerocercoids "of a smaller type" in 40 per cent of "smaller fish" in the same reservoir, but attempts to infest rats with these have so far failed (see also T. Hare, *Brit. Med. J.*, 347, March 10, 1945). In addition to this, Dr. Peterson of Yell informed Duguid and Sheppard that a species of *Diphyllbothrium* is also endemic among freshwater trout in some of the Shetland Islands.

With regard to the occurrence of *Diphyllbothrium latum* in man in west Ireland, N. O'Connor (*Brit. Med. J.*, 737, Dec 2, 1944), discussing multiple infestation of man with two types of tapeworm, states that the existence in Ireland of *D. latum* of man was first recorded by O'Farrell (*Lancet*, 1, 466, 1916, 1, 570, 1918; and *Irish J. Med. Sci.*, vi, 95, 1929). Another case was reported by O'Kelly (*Irish J. Med. Sci.*, vi, 188, 1935). The first case of multiple infestation was recorded by O'Farrell (*Irish J. Med. Sci.*, vi, 542, 1930). All these cases came from the Shannon area. O'Connor (*loc. cit.*) himself records the infestation of a husband and wife with *D. latum* in the River Erne area, near lakes not connected with the River Shannon, the wife's infestation being multiple and combined with infestation with *Taenia saginata*. Both ate perch, pike and eels, but no trout; the wife often ate undercooked meat and raw pork. The husband had never been abroad, the wife was born of Irish parents in Glasgow, which town she had visited only twice within the last twenty-three years. G. W. S. Andrews and A. C. Ogilvie (*Brit. Med. J.*, 772, June 3, 1944) record a case of multiple infestation with *Taenia saginata*. G. LAPAGE.

FORTHCOMING EVENTS

Saturday, March 24

ASSOCIATION OF BRITISH ZOOLOGISTS (at the Zoological Society of London, Regent's Park, London, N W 1), at 10 a m—Tenth Annual General Meeting, at 10 30 a m—Dr C F A Pantin, F.R.S. "The Interrelation of Biology Teaching in Schools and Universities", at 2 p m—Dr Stanley Kemp, F.R.S. "Marine Investigations", at 2 45 p m—Dr S A Neave "The Work of the Zoological Society", at 3 30 p m—Mr J C F Fryer "Zoological Interests of the Agricultural Research Council", at 4 15 p m—Dr E B Worthington "Freshwater Investigations"

ASSOCIATION FOR SCIENTIFIC PHOTOGRAPHY (at the Royal Society of Arts, John Adam Street, Adelphi, London, W C 2), at 2 30 p m—Mr J H Ridley "An Experimental Approach to Time Lapse Cinematography"

SHEFFIELD METALLURGICAL ASSOCIATION (joint meeting with the SOUTH YORKSHIRE SECTION OF THE ROYAL INSTITUTE OF CHEMISTRY) (at 198 West Street, Sheffield, 1), at 2 30 p m—Dr U R Evans "The Principles governing Corrosion Resistance in Metals and Alloys"

Monday, March 26

ROYAL GEOGRAPHICAL SOCIETY (at Kensington Gore, South Kensington, London, S W 7) at 5 p m—Dr S E Hollingworth "Zones of Rock Flow and Resulting Land Forms"

ROYAL INSTITUTE OF CHEMISTRY (at the London School of Hygiene and Tropical Medicine, Keppel Street, Gower Street, London, W C 1), at 5 p m—Dr Harold Moore "Industrial Non-Ferrous Alloys"

INSTITUTION OF ELECTRICAL ENGINEERS (at Savoy Place, Victoria Embankment, London, W C 2), at 5 30 p m—Discussion on "The Future of Synthetic and Thermoplastic Insulated Cables" (to be opened by Mr T R Scott)

Tuesday, March 27

TELEVISION SOCIETY (at the Institution of Electrical Engineers, Savoy Place, Victoria Embankment, London, W C 2), at 5 30 p m—Annual General Meeting Discussion on "The Social Aspects of Television" (to be opened by Capt C H Cazaly)

Thursday, March 29

ROYAL AERONAUTICAL SOCIETY (at 4 Hamilton Place, London, W 1), at 5 30 p m—Annual General Meeting

APPOINTMENTS VACANT

APPLICATIONS are invited for the following appointments on or before the dates mentioned

CHIEF METALLURGIST by Midland firm to take control under the General Management of the metallurgical side of the production of cold rolled mild alloy and carbon steel strip—The Ministry of Labour and National Service, Appointments Department, Central (T and S) Register, Room 5/17, Sardinia Street, Kingsway, London, W C 2 (quoting Reference No F 3759 XA) (March 28)

LECTURER IN THE ELECTRICAL ENGINEERING AND PHYSICS DEPARTMENT of the Coventry Technical College—The Director of Education, Education Offices, Coventry (March 29)

ASSISTANT ENTOMOLOGIST (temporary)—The Secretary, Edinburgh and East of Scotland College of Agriculture, 13 George Square, Edinburgh 8 (March 31)

ASSISTANT LECTURER (well-qualified Graduate) FOR MATHEMATICS AND PHYSICS, at the Norwich City College and Art School—The Director of Education, City Hall, Norwich (April 3)

CHAIR OF AGRICULTURAL CHEMISTRY—The Secretary, West of Scotland Agricultural College, 6 Blythwood Square, Glasgow (April 6)

LECTURER (full-time) IN THE DEPARTMENT OF MECHANICAL ENGINEERING of the Leeds College of Technology—The Director of Education, Education Offices, Leeds (April 7)

METALLURGIST GRADUATE for development work in large Steel Foundry in South Midlands—The Ministry of Labour and National Service, Appointments Department, Central (T and S) Register, Room 5/17, Sardinia Street, Kingsway, London, W C 2 (quoting Reference No F 2119 XA) (April 9)

CHEMIST on the staff of the WATER POLLUTION-RESEARCH LABORATORY, Watford—The Ministry of Labour and National Service, Appointments Department, Central (T and S) Register, Room 5/17, Sardinia Street, Kingsway, London, W C 2 (quoting Reference No F 3403 XA) (April 10)

FOOD CHEMIST in the Research Department of a well-known London firm to carry out the analysis of a wide range of food materials packed in metal containers—The Ministry of Labour and National Service, Appointments Department, Central (T and S) Register, Room 5/17, Sardinia Street, Kingsway, London, W C 2 (quoting Reference No F 2122 XA) (April 14)

LECTURER IN GENERAL ENGINEERING SUBJECTS, and a LECTURER mainly for ENGINEERING MATHEMATICS—The Registrar, Merchant Venturers Technical College, Bristol 1 (April 15)

WORKS PROCESS CHEMIST for new factory in India—The Ministry of Labour and National Service, Appointments Department, Central (T and S) Register, Room 5/17, Sardinia Street, Kingsway, London, W C 2 (quoting Reference No F 3705 XA) (April 17)

SENIOR POST as RUBBER RESEARCH CHEMIST with a large Company in the North of England engaged in rubber manufacture—The Ministry of Labour and National Service, Central Register, Room 5/17, Sardinia Street, Kingsway, London, W C 2 (quoting Reference No F 3360 XA) (April 17)

METEOROLOGICAL OFFICER CADETS, Department of Industry and Commerce, Dublin—The Secretary, Civil Service Commission, 45 Upper O'Connell Street, Dublin (April 20)

ENGINEER FOR THE POSTS AND TELEGRAPHS DEPARTMENT of the Government of Nigeria—The Ministry of Labour and National Service, Appointments Department, Central (T and S) Register, Room 5/17, Sardinia Street, Kingsway, London, W C 2 (quoting Reference No D 971 A) (April 21)

SENIOR LECTURER (ungraded) IN HISTOLOGY—The Registrar, The University, Liverpool (May 31)

UNIVERSITY CHAIR OF BACTERIOLOGY, tenable at University College Hospital Medical School—The Academic Registrar University of London, c/o Richmond College, Richmond, Surrey (June 25)

HIGH-GRADE TECHNICIAN (male) for laboratory concerned with the construction of moulded applicators individually fitted to patients—The General Superintendent, Christie Hospital and Holt Radium Institute, Withington, Manchester 20

TELECOMMUNICATIONS ENGINEER by S E London engineering firm—The Ministry of Labour and National Service, Appointments Department A 3(A), Sardinia Street, Kingsway, London, W C 2 (quoting Reference No Q 8 S 91)

ASSISTANT SECRETARY—The Royal Photographic Society, 16 Prince's Gate, London, S W 7 (endorsed 'Assistant Secretary')

SPEECH THERAPIST—The Director of Education, Education Offices, Moss Street, Bury, Lancs

READERSHIP IN HUMAN PHYSIOLOGY—The Registrar, University Registry, Oxford

REPORTS and other PUBLICATIONS

(not included in the monthly Books Supplement)

Great Britain and Ireland

Department of Scientific and Industrial Research Index to the Literature of Food Investigation Vol 15, No 3, December 1943 Compiled by Agnes Elisabeth Glennie, assisted by Janet Lang Hall Kueneman Pp iv+159-238 (London H M Stationery Office, 1944) 4s 6d net [152]

Glasgow Art Gallery and Museums Report for Year ending 30th June 1944. Pp 24 (Glasgow Glasgow Art Gallery and Museums, 1945) [162]

British Coal Utilisation Research Association Steam Engineering Department Progress Report for Year ending April 1944, and Programme for Year commencing May 1944 Pp 14 (London British Coal Utilisation Research Association, 1944) [202]

A Sc W Facts Pp 20 (London Association of Scientific Workers, 1944) 3d [202]

University of Leeds Report of the Librarian for the Session 1943-44 Pp 5 (Leeds The University, 1945) [222]

National Smoke Abatement Society Fifteenth Annual Report for the Year ended December 31st, 1944 Pp 16 (London National Smoke Abatement Society, 1945) 2d [222]

Tools for the Next Job A Policy of Progress through Productivity (Published for the Tory Reform Committee) Pp 64 (London Europa Publications, Ltd, 1945) 2s 6d [272]

Some Notes on the History and Principles of the Shepherd System of Air Disinfection Pp 12 (London Shepherd's Bactericidal Aerosols, Ltd, 1945) [272]

Ministry of Health Nurses Salaries Committee Mental Nurses Sub-Committee Further Recommendations and Points of Interpretation Mental Nurses S C Notes, No 2 Pp 6 (London H M Stationery Office, 1945) 1d net [272]

Imperial Forestry Institute University of Oxford Twentieth Annual Report, 1943-44 Pp 12 (Oxford Imperial Forestry Institute, 1944) [272]

Other Countries

Nutrition Problems in Relief and Rehabilitation Planning for the Post-War Area By Moses Schonfeld Pp vii+30 (New York American Chapter, Religious Emergency Council of the Chief Rabbi of the British Empire, 1944) 75 cents [52]

Newfoundland Government Research Bulletin No 14 A Biological and Economic Study of Cod (*Gadus callarius*, L.) in the Newfoundland Area, including Labrador By Dr Harold Thompson. Pp 160 (St John's Department of Natural Resources, 1943) [72]

Indian Central Cotton Committee Technological Laboratory Technological Bulletin, Series B, No 31 The Effect of Storage under certain Specified Conditions on the Quality of Indian Cottons By Dr Nazir Ahmad and A N Gulati Pp 21 (Bombay Indian Central Cotton Committee, 1944) 1 rupee [72]

South Australia Institute of Medical and Veterinary Science Sixth Annual Report of the Council, July 1943-June 1944 Pp 12 (Adelaide Institute of Medical and Veterinary Science, 1944) [72]

U S Office of Education Federal Security Agency Misc No 7 FM for Education Suggestions for Planning, Licensing and Utilizing Educational FM Radio Stations Owned and Operated by School Systems, Colleges and Universities By William Dow Boutwell, assisted by Ronald R Lowdenmilk and Gertrude G Roderick Pp n+54 (Washington, D C Government Printing Office, 1944) 20 cents [122]

Ministry of Finance, Egypt Survey Department Geodesy in Egypt By J H Cole Pp x+164 (Cairo Government Press, 1944) P T 50 [202]

Colony of Mauritius Department of Agriculture Fourteenth Annual Report of the Sugarcane Research Station, 1943 Pp ii+17 (Mauritius Government Printer, Port Louis, 1944) 50 cents [202]

Anuario del Observatorio Astronómico de Madrid para 1945 Pp 374 (Madrid Instituto Geográfico, 1944) [202]

Publicaciones de la Facultad de Ciencias matemáticas, Físicomáticas y naturales, Aplicadas a la Industria, de la Universidad Nacional del Litoral Serie Conferencias y Textos, Publicación No 21 Teoría general de las magnitudes físicas Por Prof Walter S Hill Pp 112 4 dollars Serie Técnico científica, Publicación No 22 Combustión nuclear Por Prof Walter S Hill Pp 72 3 50 dollars (Montevideo Instituto de Física, 1941) [202]

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BRITISH EMPIRE SCIENTIFIC CONFERENCE

THE address on "Scientific Co-operation within the British Commonwealth" which Prof. A. V. Hill delivered to the Royal Empire Society on January 31 has claims on the close attention of all scientific workers. In the first place, it gives an account of the actual progress that has been made in implementing co-operation since the committee appointed by the Royal Society reported in 1943. In particular, the Empire Scientific Conference to be called in London by the Royal Society either later this year or, more probably, in 1946, which is one indirect result, not merely of that report, but also of Prof. A. V. Hill's visit to India, of the more recent visit of Indian men of science to Britain and of Sir Henry Tizard's visit to Australia and Canada in 1943, will call for the active support of many more scientific workers than the sixty actual delegates contemplated.

Prof. Hill said that the Conference will probably be held in two parts, the first and more purely scientific gathering being followed by a more official conference for working out concrete plans for submission to the Governments concerned. During the interval, the visitors will travel about Britain in small groups, to see British science, industry, agriculture and medicine in operation, and above all to gain by informal discussion personal acquaintance with each other's problems, programmes and ideas. The value of this informal contact is rightly stressed by Prof. Hill, as in the British Commonwealth Science Committee's report, where it formed the subject of two of the six main recommendations, such contacts are in fact one of the most important things to implement. No organization, as we have urged repeatedly, can be an effective substitute for that full freedom of intercourse and communication, both spoken and written, which for more than five years has been severely limited by war conditions.

If it is true and right that such fundamental freedom should be restored first within the British Commonwealth and as early as possible, it is true also that these proposals to improve and extend imperial co-operation in science are also important in relation to the wider field of scientific co-operation generally, to which Dr. Joseph Needham directed attention in his plea for an international science co-operation service as a functional body parallel with the International Labour Organisation and the Food and Agricultural Office, and on which Sir Henry Dale dwelt at some length in his anniversary address to the Royal Society on November 30. Prof. Hill also emphasizes the importance for international scientific co-operation of such developments in scientific co-operation within the British Empire, and one of his reasons for urging British leadership in this field is the vital importance of building up as rapidly as possible a world organization for sharing the beneficent results of scientific discovery. Above all, it might be fittingly urged at the present time that it is essential to re-establish as early and as fully as

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possible those contacts in science which will revive in the harassed peoples of Western Europe the sense of common traditions and heritage in science no less than in law and government, in humanism and in Christianity, with all that such a revival can mean to them as they address themselves to the reconstruction of their national life

While that appears to be the setting in which Prof. Hill rightly views proposals for imperial co-operation in science, the practical tone of his address is unmistakable. His visit to India has convinced him that the best hope of friendly co-operation between India and Britain lies in the scientific, technical and medical fields. It is now probable that the Government of India will set up an Indian Scientific Office in London, and an Indian Scientific Liaison Service may be established with its headquarters in Delhi, its main overseas office in London, and branches in other countries.

Other promising developments are also noted by Prof. Hill, such as the work of the Colonial Research Committee and of the Colonial Products Research Council, and closer contact and co-operation between these bodies and the Dominions and India could scarcely fail to be of mutual advantage in dealing with many scientific, technical, agricultural or medical problems. Again, the attachment of two able scientific advisers to the Middle East Supply Centre is of special interest. In the region covered by the Middle East Supply Centre, science, particularly the biological sciences, could play a dominant part in determining the welfare of the peoples and their relations to the outside world. Problems are encountered in agriculture, irrigation and soil survey, in land conservation and erosion, in geology, meteorology and water supply, in forestry and the preservation or utilization of flora and fauna, in health and nutrition and the like, which are closely analogous to those encountered in other parts of the British Empire, and, further, neglect of the scientific factors will lead to trouble and difficulties which no political astuteness can curb or avoid.

It is, however, in his references to the specific problems in which scientific co-operation within the British Commonwealth is of practical importance that Prof. Hill's address is of the greatest interest. Here he enforces the point that such co-operation alone can provide the solution to important practical problems, some of which, such as that first mentioned by him, namely, the fear of isolation, which deters first-class teachers and research workers from accepting posts in more distant centres, have been raised in recent reports like those of the Colonial Research Committee. Their effects, and means of overcoming it, are obviously problems not for one colony or dominion alone, but for joint consideration and a common policy.

Similarly, the need for quick and frequent personal contacts between research workers in analogous fields is widely recognized, but almost certainly an imperial policy alone can ensure that air transport will supply such contacts regularly for people who are mostly not well paid and have no great political or industrial standing. Again, regular interchange of personnel

between the scientific staffs of universities, industrial firms and research institutions throughout the Commonwealth must largely wait on the formulation of common arrangements, including an appropriate pension system. Allied to this is the problem of organizing and financing the training of young research workers and the higher grades of technologists and workmen by exchange between countries which have special opportunities to offer.

Another group of problems instanced by Prof. Hill as calling for co-operative attention is the combined study of natural resources and conditions—forests, minerals, land utilization, water-power, plants, animals, pests and diseases, and the application of the principles of lend-lease both to their investigation and the utilization of the new knowledge so gained. Here we touch on the question of regional research. Certain regions form natural units for research and development in particular subjects or groups of subjects, although the regions may fall, as in Africa, under the authority of different Governments. The means of securing co-operation and the sharing of effort and expense in such regions require working out, while again, in attempting a concentrated attack on a key problem, we lack the machinery for deciding on the problem and on the method, the scale and the direction of attack and the means by which the expense is to be shared.

Finally, Prof. Hill refers to the question of science and imperial defence, and faces frankly the fact that scientific workers have been troubled in the past as to secrecy being a cover for inefficiency, and the danger of its breeding fear and suspicion. He insists on the need for critical minds and up-to-date methods, for contact with recent scientific discoveries and industrial technique, and for interchange between scientific workers in Government service, in industry and in the universities throughout the British Empire. The relations between civil and military research need to be worked out critically and with imagination, here it may be noted that three of the nine points of imperial defence which Lord Chatfield pressed in the House of Lords on March 7 as requiring investigation closely concern scientific workers. Two of these questions, whether our statesmen require better opportunities of informing themselves on strategical and technical problems of defence, whether service Ministers, when possible, should serve three or four years in their departments so as to master the technical problems, could well be included in the agenda of the proposed conference. The third question, whether the defence of the Empire and the security of the British people could be removed from party strife, or some other means devised to lessen political differences on the basic problems of defence, might also be considered.

Prof. Hill's address shows clearly that a definite practical programme and not mere generalities can be placed before both sessions of the forthcoming Empire Scientific Conference when it meets. There will be ample scope for critical discussion and imaginative planning, but if the Conference is to result in the bold executive action desired, scientific workers must manifest their interest and support in

no uncertain manner in the months preceding its assembly. The application of the methods of biological science, in its widest sense, to the problems of general welfare, and of physical and engineering science to economic and industrial problems, calls for much effort by the individual scientific worker, and, as Prof. Hill points out, may involve facing political as well as scientific and technical issues. Not everyone who recognizes as desirable that fuller and more effective co-operation among men of science for which Prof. Hill pleads will feel as sanguine as he is that such co-operation in the British Commonwealth will appreciably influence the relations of the world as a whole, but it must help rather than hinder international co-operation generally. That the closer co-operation of scientific workers and fuller and freer contacts between them are important factors in the continued advance of science cannot be denied. They are indeed essential conditions in order that mankind may enjoy those higher standards of health and welfare which science has put within our reach. Prof. Hill's address should stir scientific men to take their part not only in thinking about the technical and scientific aspects of the special problems he has indicated for consideration by the Empire Scientific Conference, but also, and equally important, in educating their fellow-citizens as to what is at stake. They can prepare the way for the measures required to implement such co-operation, and to establish and safeguard that code of common ethical standards which, as Prof. Hill so emphatically urged, will be a safeguard against the abuse of science either in peace or in war.

A PHYSICIST LOOKS AT GENETICS

What is Life?

The Physical Aspect of the Living Cell. By Prof. Erwin Schrodinger (Based on Lectures delivered under the auspices of the Dublin Institute for Advanced Studies at Trinity College, Dublin, in February 1943) Pp viii+91+4 plates (Cambridge At the University Press, 1944) 6s net

AS a result of the War, many scientific workers have been too busy with the applications of science to keep up even with the development of their own branch. Schrodinger, as an exile in neutral Eire, has found the leisure to study another, namely, genetics, which he describes as "a new branch of science, easily the most interesting of our days." I wonder if posterity will find crossing-over as interesting as exchange energy, or mutation as atomic transition. However this may be, every geneticist will be interested in Schrodinger's approach to his or her science.

Schrodinger sets out to answer the question "How can the events in space and time which take place within the spatial boundary of a living organism be accounted for by physics and chemistry?" He believes that they can, but not by present-day physics and chemistry. Accepting the view, first, I think, put forward by Koltsch, that a chromosome is a giant molecule, Schrodinger describes it as an aperiodic crystal. Thus it may be expected to have some of the properties of a crystal, including that of

self-reproduction, and yet to be of so highly complex a structure that it can act as a "code-script" for the development of an organism. He thinks that just because a gene is of molecular dimensions, and there are only one or two genes of a kind per cell, one cannot apply statistical mechanics to the behaviour of genes. This is perhaps not quite certain; for an organic catalyst can, in favourable circumstances, transform more than 100,000 substrate molecules per second. If genes are catalysts of this order of activity, even a single gene requires statistical treatment.

Much of the book is devoted to mutation, and the author not merely accepts Delbruck's account of this process, but also writes that "If the Delbruck picture fails, we would have to give up further attempts." This seems a rash statement from a quantum physicist. The modern 'picture' of an atom is not superficially very like Bohr's picture, for discrete orbits of electrons have been replaced by a continuous probability distribution. Yet Bohr's theory explained so much that it was hard to believe that it would be so greatly modified.

Actually I believe that the Delbruck picture will have to be modified profoundly, for the following reason. Schrodinger (p. 65) states that the single event which produces a mutation "must be an ionization or similar process." Lea and Catchside, in unpublished work communicated to the Genetical Society, which they very kindly allow me to quote, produce strong evidence that many, if not all, lethal mutations produced by irradiating *Drosophila* spermatozoa are due to chromosome breakage followed by restitution, and in *Tradescantia* they¹ calculate that "at least 17 ionizations must be produced in a chromatid to cause a break". In spite of this they think that the 'target-area' gives the size of the gene correctly. In fact, as so often in quantum mechanics, a simple theory gave fairly correct results, but nevertheless had to be modified.

Again (p. 64), the fact that the mutation-rate of wild-type genes is more enhanced by temperature than that of less-stable mutant genes is neatly explained on quantum-mechanical grounds. But Fabergé and Beale² found that the mutation-rate of a very unstable gene actually fell off at high temperatures. Perhaps there are more things in chromosomes than are dreamt of even in wave mechanics.

I make these criticisms not from any desire to denigrate the book before me, but because many geneticists will read it, and all of them should. And not only geneticists. The physiologist who can assimilate the idea that a living organism feeds on negative entropy will come back to the study of metabolism with a slightly novel set of questions to ask. Nevertheless, a whole series of biological problems are not raised. Many biologists have found it impossible to explain the facts of organic regulation on mechanistic lines. Prof. Schrodinger's views on genetics are so interesting that I hope he will tackle this problem, too, in another book. In a living organism we find a hierarchy, so to say, of normal conditions. A man does his best to keep the partial pressure of carbon dioxide and the concentration of bicarbonate ions in his plasma constant. If he fails in either respect, he will use his lungs, kidneys, or both, to bring their ratio, and therefore his pH, back towards normal. But even pH is less important than an adequate oxygen supply. And so on. A mathematical physicist might be able to find physical analogies, or even explanations, for such facts as these.

A mechanist must either give a mechanistic account of mind, or turn a somersault. In his epilogue, Schrodinger does the latter with very great elegance, and adopts a metaphysical position which is roughly that of Samkara Acharya. There is only one soul, the difference between yours and mine being an illusion. I think that here, too, the history of quantum mechanics suggests that the truth may be somewhere between mechanism and advaita metaphysics. There is no way of distinguishing between the two electrons in a hydrogen molecule, you cannot put a spot of red paint on one of them. This fact makes a difference to their behaviour. Nevertheless there are two electrons, not one. Perhaps the relation between two souls is a little more like that between two electrons than between two tables, and these philosophical problems will be solved, or at least transformed, when our descendants learn to apply to mind the kind of analysis which Schrodinger has applied to matter.

However that may be, the book is one to which one comes back again and again. I have lent it to several genetical colleagues, and the verdict has been uniformly favourable. We may disagree with details, or even with fundamental principles, but we cannot stop reading it before the end. Unfortunately, it contains only 93 pages. There are 93 elements, but 738 isotopes have so far been described. Perhaps we may hope for a book of 738 pages on biology in general. Prof Schrodinger need not doubt that it will find readers.

J. B. S. HALDANE.

¹ *J. Gen.*, 44, 216 (1942)

² *J. Gen.*, 43, 173 (1942)

PSYCHOLOGY OR RELIGION?

The Lady of the Hare

Being a Study in the Healing Power of Dreams. By Dr John Layard. Pp 277 (London: Faber and Faber, Ltd., 1944.) 12s 6d net.

THIS volume, which is attractively produced and well illustrated, purports to be the first verbatim account ever published of a dream-analysis on Jungian lines. (Jung's numerous own seminar accounts of dream analyses published in limited number for the use of his students may not have come to the notice of the author.) In Part 1, twelve professional sessions are described in which a number of dreams and so-called visions of a woman patient were discussed. This is followed by a brief theoretical discussion, a summary of the dream process, and a description of the subsequent remarkable development of the patient's mentally defective daughter. Since one dream of the patient contains the figure of a hare which she is meant to kill or sacrifice, Part 2 of the book deals with the mythology of the hare, and the author follows up the hare motive in myths and folklore of India, China, Egypt, Africa, North America, Europe and classical antiquity. In Part 3, more dreams about hares and rabbits are communicated.

As Dr Layard, the anthropologist, has the well-known informative "Stone Men of Malekula" to his credit, one opens this book by Dr Layard, the psychologist, with high expectations of finding a full and well-substantiated account of a case-history illustrating the practice of Jung's analytical psychology. The author, however, does not fulfil these expectations, but expounds his own psychotherapeutic technique and healing powers, which bear little

relation to Jung's practice and theory of analytical psychology. The result is a book which will fill the informed student of analytical psychology with dismay and induce the uninformed reader to identify the Jungian method with that of the author, which is a fallacious assumption.

Jung defines the aim of analytical psychology as that of individuation. The author defines it (p. 18) as that of salvation, thereby discarding the scientific phenomenological approach of Jung, identifying psychology with religion and the psychologist with the priest or magician (the patient's "You are a minister of God", p. 47), in defiance of the teachings of Jung (cf. "The Relations between the Ego and the Unconscious"). Nor is the author following Jungian practice in treating the transference of the "Saviour Archetype" by "disclaiming it on every occasion when it arose". "emphasizing the obvious unsuitability of any such personal projection" (p. 82), for according to Jung (*loc. cit.*) the problem of transference defies rationalizations of this kind. However, most alien to the point of view of analytical psychology, which refrains from making sweeping, scientifically untenable claims and conforms to the standards expected from proper clinical psychological research, are two basic aspects of the account given of dream-analysis which reveal the author's unfamiliarity with, or disregard of, the Jungian practice of dream-analysis.

One is that the author gives the unsuspecting reader the impression—and appears to share it himself—that the twelve interviews described, comprising the discussion of twenty-five dreams and visions and covering a period of about two and a half months, perfected a cure comparable with that attained in the gradual process of growth facilitated by a proper analysis. His insistence on quick results ("The deeper the analysis the quicker the cure", p. 20, "The whole interview had lasted just $\frac{1}{2}$ hour, but it had been enough", p. 36; "As last week, the whole interview lasted less than $\frac{3}{4}$ of an hour", p. 58) betrays the anthropologist's fascination for the magic practices of the medicine man, while his belief in miraculous and spectacular healing reminds one of the claims of faith-healers. The claim that his twelve-interview treatment is representative of Jungian practice shows grave lack of knowledge of the work of Jung and his school.

The other main aspect incompatible with Jungian principles and practice is the victimization of the patient during the sessions, as described. Even granting that the expression "verbatim account" may be an exaggeration and should not be taken literally, there remains the fact that undue prominence is given to the author's intuitions about the dreams and his suggestions to the patient, while the patient's own spontaneous associations are partly not admitted and partly not related. This practice is alien to that expounded by Jung.

Thus the main part of the book gives the reader insight into Dr Layard's psychotherapeutic technique and powers, but the reader must beware of confusing this, as the author has done, with the technique of Jungian analysis.

In Part 2, when collecting the hare motive as found in mythological material of primitives and the ancients, Dr Layard, the anthropologist, is at work once more, and this part, though of little import for the case described, forms a work of reference on the hare motive which will be very useful for the student of mythology.

The author would be well advised to write the promised second volume without reference to Jung's analytical psychology, for the reference to Jung is apt to create confusion and do a disservice to Jung, and incidentally to the author himself

H J JACOBY

BROADCASTS ON FARMING

'Farming Talks'

By W S Mansfield Pp 119+8 plates (Worcester Littlebury and Co, Ltd, n d) 7s. 6d net.

Farming To-day Broadcasts

Vol 2 A Series of Agricultural Education and Technical Development Broadcast Talks Pp 130+12 plates (Worcester Littlebury and Co, Ltd, n d) 7s 6d net

THESE two groups of farming broadcasts are presented without alteration in form, a procedure which has both advantages and demerits. For those who did not hear the original talk or discussion, the structure, particularly when dialogue, does not make for easy reading and there are occasional difficulties of meaning. Those who have heard most of the broadcasts—and they will probably be the majority of readers—will be able to recapture the atmosphere and enjoy again the accents of the speakers.

Since 1937 Mr Mansfield has been a regular and notable contributor to B B C broadcasts on farming topics—he takes part in six of the discussions in the second series of 'Farming To-day'. The talks and discussions of this second volume were given in 1943 and the first quarter of 1944, and are arranged chronologically. About half of the 'Farming Talks' were given before the War, and the remainder nearly all in its first two years. The illustrations in both volumes are well reproduced, their function is decorative, having no special reference to textual matter.

War needs have changed the character of these broadcasts. Mr Mansfield's earlier talks were aimed at a wider audience, though intended for farmers, they were designed also to interest the townsman in the land and its problems. There are discussions—for example, one with Dr Sanders on high and low farming—but mainly they are straight talks, with at the end perhaps a short dialogue with his farm bailiff or rat-catcher, for illustrative purposes. In these he succeeds very well in catching something of the spirit of the land. Talking, in 1938, on successful farming, he quotes Xenophon to the effect that the difference between those who succeed and those who do not is a difference not of knowledge but of care in management. To the extent of conceding that knowledge, experience, good land and adequate capital are not enough without character—and especially adaptability to changing conditions—Mr Mansfield agrees.

Great changes have been forced on British agriculture by war needs, after the War there must be a further change, which, whatever else it may be, will not be a reversion to the conditions of 1939. The war-time broadcasts have been educational and propagandist in character, aiming at spreading new ideas, publicizing the results of agricultural research, and generally supplementing the work of the war agricultural committees.

Some of the contributors to 'Farming To-day Broadcasts' are farmers, some are specialists. Welsh

hill land improvement, sugar beet, haymaking, care of machinery and composting straw are among the topics of discussion. Not all the talks are concerned with immediate needs, particularly where livestock are involved (because of their low reproductive rate) there must be long-term planning. There has been a great decline in the sheep population of Britain. Four discussions deal with hill sheep, arable and grassland flocks, and disease, and consider probable sources and methods of management in post-war agriculture. Naturally none of the subjects is treated at any great length.

HYDRAULICS IN THEORY AND PRACTICE

A Treatise on Applied Hydraulics

By Prof Herbert Addison Third edition, revised and enlarged Pp viii+614 (London Chapman and Hall, Ltd, 1944) 32s net

PROF ADDISON explains, in his preface, that his aim in writing this book was to present a compact summary of the fundamental principles of hydraulics and the manner in which they are applied, and he expresses the hope that the book will meet the requirements of three classes of readers—the engineer in practice who desires to keep in touch with modern developments in hydraulics, the general student of engineering and the student who wishes to specialize in the subject and who desires a reliable basis for further study. In these aims he has succeeded admirably.

The first part of the book deals with theoretical principles and the second with practical applications, the whole being extremely well illustrated by diagrams and photographs. A striking feature is the arrangement of the subject-matter, thus the numerous worked examples, and problems for solution by the student, are collected together towards the end of the book and reference is made to them when illustration is necessary. Such arrangement has the advantage that the continuity of the text is not interrupted and, in any section, the student may obtain, in the first instance, a clear and concise statement of the engineering aspect of each problem as a background to his study of the theoretical discussion.

The second part of the book introduces a wide range of applications, including the flow of water in pipes, channels and streams, the control of water, viscous flow, hydraulic turbines, pumping machinery, power transmission and hydraulic measurements.

From the method of presentation there is ample evidence not only of Prof Addison's breadth of knowledge, but also of his experience as a teacher and his appreciation of the problems which confront the teacher and student alike, in dealing with the complexities of a subject in which it is particularly difficult to apply the results of theoretical investigation to the conditions which prevail in practice.

While this is an excellent text-book for the use of students preparing for university and institution examinations, it is much more than that, for it summarizes the results of modern research, is equipped with a comprehensive bibliography of recent publications, and its descriptions and illustrations refer to up-to-date installations. Civil, mechanical and electrical engineers will find it a most complete and informative book of reference on hydraulic engineering.

J. B. TODD

Your Daily Bread

By Doris Grant Pp 94 (London Faber and Faber, Ltd., 1944) 4s 6d net

THIS little book covers a lot of ground. Essentially, Miss Grant sets out to prove that white bread—or “murdered bread” as she prefers to call it—is responsible for much of our poor and indifferent health, and she pleads the case for wholemeal bread as the remedy. The book contains much scientific material, and although some of it is not very critical, the case is skilfully presented. It is suggested, for example, that because nicotinic acid helps to create skin beauty, “one of the best and easiest ways of ensuring a flawless complexion is to eat whole-wheat bread”.

A section of the book deals with the place of bread in a balanced diet and gives specimen menus. Miss Grant abhors imported or processed foods of any kind, and she is supported in this by Sir Albert Howard, who contributes a chapter on the importance of fertile soil for the production of best-quality wheat. Sir Albert includes all canned foods, chilled meat and frozen fish with white bread as “murdered foods”, and claims that they are responsible for the poor physique of our urban population. Further, he condemns the use of artificial manures of all kinds. Another chapter reproduces the Cheshire memorandum, a statement by a number of medical practitioners from that county on some general aspects of nutrition including the arguments in favour of wholemeal bread.

The book concludes with a number of recipes for cakes, scones, biscuits, etc., using wholemeal flour. Perhaps the most important recipe is that for the ‘Grant loaf’. A sample was made for the reviewer, strictly according to instructions but using ordinary salt and cane sugar, by a skilled baker. When eaten at tea by a family of four, two preferred it to National bread, however, when two days old, one only was still enthusiastic. It is not easy to break dietary habits.

School Physics

By T M Yarwood Part 2 Pp x + 438 (London Macmillan and Co., Ltd., 1945) 7s 6d

THIS book includes all that is required for the various School Certificate examinations. Together with the previous more elementary part, it provides the basis for a sound school course in physics. Good features are the frequent references to the applications of science to everyday life, the inclusion of a chapter on radio, and the numerous problems solved in the text.

In the reviewer’s opinion, however, it is a mistake to cover the whole of physics in two books. The inevitable result is that the presentation is not so attractive as in well-known series of books covering the same ground. Having attempted it, dullness might have been avoided by the lavish use of half-tones, but there are only half a dozen in the 400 pages.

There are a few slips and inadequacies two may be mentioned. On p 73 it is said that the gas ejected from a jet-propelled plane “presses on the air behind the aeroplane, and the machine is thus pushed forward”. On p 131, stress is laid on the thermal capacities of water and mercury, water and sand, etc. The effect of their relative densities should also be mentioned when comparing the thermal capacities of two bodies, for example, two thermometers.

J P STEPHENSON

On a Class of Linear Transformations Connected with Group Representations

By Lars Gårding (Meddelanden från Universitets Matematiska Seminarium, Band 6) Pp 125 (Lund C W K Gleerup, 1944) n p

BASIC spinors are defined with reference to the equation $T^{-1}\gamma_i T = \Sigma a_{ij}\gamma_j$, where γ_i represents a set of anti-commuting matrices, $[a_{ij}]$ is the matrix of an orthogonal transformation, and T is the matrix of transformation for basic spinors. Dirac’s equation for the electron is of the form $\nabla^2\psi = k^2\psi$, where ψ is a basic spinor. The same equation, but with ψ representing quantities of other types, occurs in other contexts in quantum theory and nuclear physics.

Dr Gårding sets himself the problem of investigating the generalized equation $S^{-1}V_i T = \Sigma a_{ij}V_j$, where V_i represents a finite set of matrices, and S , T , and $[a_{ij}]$ are any representations of a continuous group, in particular of the orthogonal group with $S = T$. His applications are concerned mainly with the solutions of $\nabla^2\psi = k^2\psi$ for different types of quantity ψ .

In many instances the constructions seem unnecessarily elaborate, and this makes the thesis difficult to read. It would appear very probable that the principal conclusions could be obtained in a more direct manner. Nevertheless, the thesis is very interesting and suggestive, and many detailed formulæ are obtained which in themselves have some value. It shows considerable mastery over many aspects of group representational theory, and many known results are recapitulated incidentally.

The work shows considerable promise, and future publications by the author will be awaited with interest.

D E LITTLEWOOD

Principles of Magnetic Crack Detection

A Practical Treatise specially written for those about to Operate the Process. By H Bevan Swift Pp vi + 105 (London E and F N Spon, Ltd., 1944) 10s 6d

MAGNETIC methods have proved useful in the detection of cracks, too inconspicuous to be seen without such aid, in steel. This handbook is in the main a description of the apparatus for carrying out such tests in the laboratory or workshop. Several commercial forms of instrument are described, with a general account of the principles of the method. In one type a direct current is passed through the object being tested, and the concentrated field at the edges of a crack is made visible by pouring on a suspension in light paraffin of a highly magnetic preparation of iron oxide. In the second type, suitable for steels with a higher retentivity, a heavy but very short electrical impulse is sent through the object, and the ink is applied afterwards. Only actual experience enables an observer to decide on the significance of the indications given by the magnetic ink, and to distinguish between cracks and accumulations of the magnetic material caused by sudden changes of section or by casual scratches. Methods of demagnetization have to be applied when, for example, parts for aircraft are being tested.

There is a short note on the testing of bars by comparison with a standard, using a null method. Actually, this plan has been used extensively in some works for the testing of small parts, such as chain links, for correct heat treatment, a definite relation being found between the hardness and the magnetic properties, so that a very rapid sorting of correctly from incorrectly treated parts is possible.

ARTIFICIAL PRODUCTION OF COAT COLOUR IN THE ALBINO RAT

ITS RELATION TO PATTERN IN THE GROWTH OF HAIR

By DR. ALEXANDER HADDOW, DR. L. A. ELSON and DR. EDNA M. F. ROE

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AND

G. M. TIMMIS

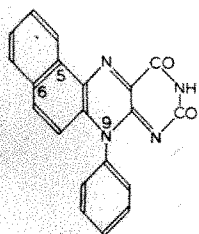
Imperial Chemical Industries, Ltd., Manchester

DURING experiments on growth, which were designed to test the action of a series of flavins, a hitherto undescribed property was encountered in one of these compounds (9-phenyl-5 : 6-benzo-*iso*-alloxazine¹), the structure of which is shown in Fig. 1. Quite unexpectedly, injection of 20–30 mgm. of this substance, in albino rats, produced an orange-yellow pigmentation of the hair. It was then observed that the coloration so produced is usually restricted to certain areas of the coat, in a way which varies considerably from one rat to another, but nevertheless conforms to a characteristic type of pattern (Fig. 2), of which the most striking feature is a pronounced degree of symmetry about the longitudinal axis. Study of some scores of similarly injected rats from the same albino colony soon revealed the regular recurrence of pattern types, which it was comparatively easy to arrange as a roughly transitional series: these facts conveyed a strong impression of a certain unity of design, in which each individual represents only one stage in a continuous rhythmic process. That the pattern which may be elicited in individual animals is variable was proved by administration of the compound at intervals of one to three weeks, fresh zones of colour appearing in response to each such injection: hence its form depends (in the majority of cases at least) upon a fluctuating process, and not upon one which is fixed, or pre-determined, genetically or otherwise.

Relation of Pattern to the Growth of Hair

That the developmental process involved might concern the regeneration of hair was suggested by a number of facts. Dry² recorded that growth of hair on the flank of the rat may be restricted to a strip about half an inch wide running along the length of the body: such a band of growing hair had frequently been observed by the present authors in earlier work,

and the irregular distribution of hair regeneration in the rat had also been noted by others^{3,4}. In experiments to test this hypothesis—that the pattern-form is determined by the growth of hair—normal rats were shorn dorsally and laterally from the level of the ears to the root of the tail and down to a low ventro-lateral level, and the subsequent course of regeneration was then plotted, at intervals of a few days. At once it be-



9-phenyl-5 : 6-benzo-*iso*-alloxazine
Fig. 1.

came apparent (Fig. 3) that only limited regions of the coat are regenerating hair at any given moment, that these areas are disposed in a symmetrical arrangement similar to the patterns revealed by injection of the specific *iso*-alloxazine, and that their variety is due to the varying rate of progress of the growth-wave front. It was further observed that the advance of the wave is in general more rapid on the back and belly, and slower on the sides, and that the growth-wave cycle, traversing the surface of the body, is complete in a minimum period of approximately six weeks. But the whole cycle may be greatly disturbed, and prolonged, by factors connected with nutrition, season, lactation, and age. From these experiments it seems probable that the rat coat is replenished by a complex series of regular waves; in individual animals the pattern may be modified by

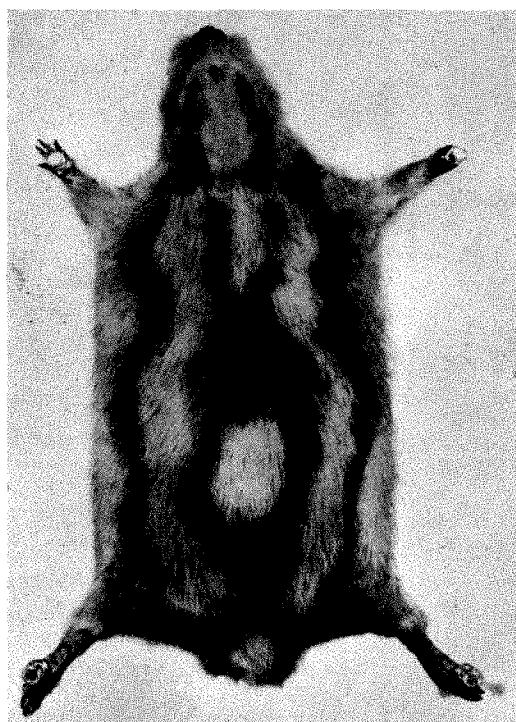


Fig. 2. COLOUR PATTERN PRODUCED BY TWO INTRA-PERITONEAL INJECTIONS (AT AN INTERVAL OF ONE WEEK) OF 25 MGm. 9-PHENYL-5 : 6-BENZO-*iso*-ALLOXAZINE IN ARACHIS OIL (FILTER EMPLOYED: ILFORD TRICOLOUR BLUE No. 304).

isolated bursts of growth, or by a sudden subsidence.

It now appeared that the hair coloration produced by 9-phenyl-5 : 6-benzo-*iso*-alloxazine is due to a localization, in growing hair but not in non-growing areas, of the injected compound or of a derivative; and evidence confirmatory of the latter point was soon obtained from direct examination of the hair pigment itself.

Nature of the Hair Pigment

In order to isolate the pigment, several grams of the coloured hair were treated with glacial acetic acid; after addition of chloroform, removal of the acid with water, and chromatography of the chloroform extract, the hair pigment was obtained as an orange-yellow fluorescing substance, the ultra-violet absorption spectrum of which showed the presence of the injected compound or of some simple derivative which is spectroscopically indistinguishable under the condi-

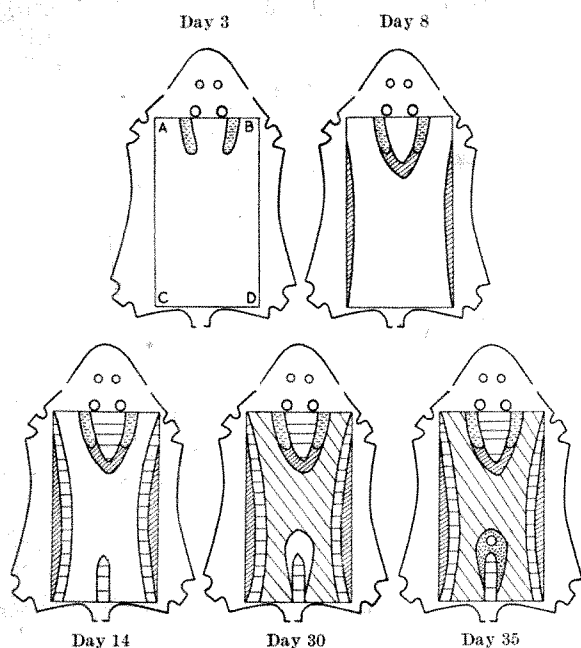


Fig. 3. REGENERATION OF HAIR AT 3, 8, 14, 30 AND 35 DAYS AFTER SHEARING THE AREA OF ABCD. SIMILARLY HATCHED AREAS ARE THOSE IN WHICH HAIR IS GROWING AT THE SAME TIME AND IN WHICH THE ALLOXAZINE PIGMENTATION WOULD DEVELOP IN RESPONSE TO ADMINISTRATION OF THE COMPOUND AT ABOUT THAT TIME.

tions employed; by this means it was calculated that there is approximately 0.1–0.2 mgm. of 9-phenyl-5:6-benzo-*iso*-alloxazine in the fluorescent eluate obtained from 1 gm. of hair.

The derivation of the hair pigment from the administered compound had thus been virtually proved, and an explanation obtained of its selective localization, namely, to those tracts of hair alone which are in active growth at the time of injection.

Mechanism of Localization

It was next found possible to indicate the mechanism of such localization from a study of the blood capillary circulation to the hair follicles, in rats which had previously been sheared as described. Visualization of the capillary system, in permanent preparations (achieved by the injection, under ether anaesthesia, of 1 ml. of a 15 per cent solution of chlorazol sky blue FFS into the femoral vein), revealed that by far the greatest density of capillaries occurs in those positions which correspond to the advancing edge of the growing hair, with a sharp cut-off at the receding edge. This observation is believed to be entirely new; it is, of course, highly suggestive, not only of the means by which the growth-wave progresses, but also of the way in which the circulating pigment enters the cuticle and cortex of the growing fibre. It would seem reasonable to infer that the constantly moving patterns of hair-growth appear in response to rhythmic alterations in the distribution of blood to the hair follicles, so that, as capillaries close down, the growth of hair recedes, while at the same time capillary activity is apparently spreading to other regions, in which the follicles at once react, and growth of hair is resumed. It is also likely that the pigment enters growing areas partly because these are the only ones in sufficiently active interchange with the general circulation. Such an interpretation was strongly supported by capillary

visualization in rats which had been both sheared and injected with 9-phenyl-5:6-benzo-*iso*-alloxazine, all these procedures being carried out within one week in order to obtain near correspondence. By this means it was possible to study capillary density, the position of the wave front, and the pigmented tract simultaneously, in a single preparation, and to show that they have precisely the same distribution.

Some attention has also been paid to the mode of chemical transport of the compound, and particularly whether this might be brought about in combination with cystine in the elaboration of keratin. Direct evidence is here less easily obtained, but it may be said that the alteration in urinary sulphur partition produced by injection of 9-phenyl-5:6-benzo-*iso*-alloxazine (in an experiment by Dr. F. L. Warren) is at least consistent with conjugation between the pigment and cysteine.

Chemical Specificity: Coloration and Absorption

The phenomenon was at first believed to depend upon a high degree of chemical specificity. No pigmentation had been noted in earlier and similar experiments with the first five members of the homologous series of 9-alkyl-5:6-benzo-*iso*-alloxazines, that is, those compounds in which the phenyl group of 9-phenyl-5:6-benzo-*iso*-alloxazine is replaced by a methyl, ethyl, *n*-propyl, *n*-butyl, or *n*-amyl group. Closer inspection has, however, shown that all these compounds do in fact produce slight traces of coat coloration, which is nevertheless far short of the intensity resulting from 9-phenyl-5:6-benzo-*iso*-alloxazine. A very satisfactory direct correlation has been established between the intensity of coloration produced and the excretion of a pigment, for the most part identical with the administered substance, in the faeces and urine: from this it is obvious that the outstandingly active compound is equally outstanding in its rate of elimination. Assuming the rate of output reflects the rate of uptake of the compound from the tissues, it is concluded that the intensity of coloration produced is correlated, within this series, with ease of absorption, and that such is conferred by the phenyl group to a marked degree. Among related substances, a slight degree of hair pigmentation is induced by 9-phenyl-*iso*-alloxazine, that is, the compound differing from 9-phenyl-5:6-benzo-*iso*-alloxazine in the absence of the angular ring.

Other Aspects

In a topic of such obvious and broad interest from both the biochemical and the zoological aspects, many other features have emerged, or are being investigated, relating to the physiology of hair growth and animal pigmentation. For the purpose of the present communication some of these may be summarized more shortly. It has been noticed, for example, that for any group of follicles, both capillary activity and hair growth are inhibited for some time after the cessation of a period of activity. With reference to this, an attempt is being made to determine the effect on the wave front of areas which have been rendered out of phase by epilation. There is also some evidence that the capillary waves move not continuously but in a series of pulses, and it is an interesting possibility that this rhythmic activity of the capillary wave front may be related to some similar rhythm in the sympathetic nervous system. This is especially so in view of a suggestion, based on the observation that concave sections of the wave

front occasionally tend to 'fill', and so smooth themselves out, more rapidly than the entire front advances, that the movement is dependent upon the release in the tissues of a chemical substance, which might accordingly reach a higher local concentration in the troughs of the pattern than at the crests. However, such a neurohumoral mechanism still remains to be fully tested by experiment.

The pigmentation phenomenon is being studied further in relation to sex, age, genetic constitution, and species. It has been noted that the intensity of pigmentation following injection tends to be slightly greater, other factors being equal, in male rats than in females. In practically all cases the pattern evoked was of similar type and behaviour in hooded rats (of constitution *CCss*), in coloured rats (*CCSS*), and in albino rats of the constitutions *ccss* and *ccSS*—thus there is no indication that the pattern revealed is related to a genetically determined pattern already present, whether manifest or latent. (For assistance in the isolation of these genotypes we are much indebted to Dr P. C. Koller.) Some allusion may also be made to the possible affinity between the capillary and hair-growth pattern in the rat, and striped or banded pigmented patterns in other mammals.

So far as the behaviour of 9-phenyl-5,6-benzo-*iso*-alloxazine in other species is concerned, only brief mention may here be made of its effects in mice. No action of any kind has been observed following administration of the compound (by injection or by feeding) to stock albinos or mice of the *R* III and Strong *A* pure lines. On the other hand, prolonged feeding (over many months) to black-eyed or so-called 'dominant' whites has apparently resulted in a slow increase of yellow pigmentation, although only very slight in intensity, confined to the dorsum and flanks. It by no means follows that the *iso*-alloxazine most effectively absorbed by growing rat hair is likely to be the most penetrating in other species, and having regard to the interest which would attend any extension of the phenomenon to mice, other compounds are being studied with this consideration in view.

Lastly, from the chemical side alone a wide field of inquiry can be opened up. How far molecular constitution may be modified, while still retaining this curious property, and how far the colour of the pigments themselves can be varied, within these limits, have so far only been studied in a very preliminary way. However, data have already been obtained concerning various colourless degradation and oxidation products of 9-phenyl-5,6-benzo-*iso*-alloxazine, which may conceivably have some bearing upon the chemical basis of albinism. Also, it may be of importance to relate these synthetic compounds to the so-called 'xanthic' pigments, of both known and unknown molecular structure (and including the butterfly wing pigments and other pterins), such as possess physiological importance or have a wide distribution in Nature.

Poulton, in his book on the colours of animals⁵, directed attention to what he classified as 'non-significant' colours, that is, pigments without physiological value in respect of their colour as such. But he also stressed their importance, as the material out of which natural selection can create 'significant' colours, namely, those with special functions in protection, concealment, mimicry, adornment, and so on. We may conjecture that if a mammalian species, in which the growth of hair followed the same rules

as apply in the rat, were to form a pigmented metabolic product with the properties of the *iso*-alloxazine, coat colour would inevitably result. It is then a legitimate surmise, following Poulton, whether such an arrangement might not become genetically fixed, or subject to natural selection, and thus confer some permanent biological advantage, protective or otherwise. This, however, is a matter of speculation. So far we can only say that the alloxazine colouring is adventitious and artificial, but may be potentially significant, in Poulton's sense, as well.

It is hoped in due course to publish a fuller account of this investigation elsewhere.

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⁴ Cunha, T. J., Kirkwood, S., Phillips, P. H., and Bohstedt, G., *Proc. Soc. Exp. Biol. Med.*, **54**, 236 (1943).

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DORMANCY IN BRITISH-GROWN WHEAT

By E. N. GREER and J. B. HUTCHINSON

Cereals Research Station, Ministry of Food, St. Albans

BEFORE the War, only a relatively small percentage of the wheat used in bread in the British Isles was home-grown. During the War, however, the acreage of home-grown wheat has more than doubled, and a large proportion of this wheat is used in bread-making grists (on occasions as much as 60 per cent of the grist). This in turn has raised the question of the most suitable varieties for bread-making. Unfortunately, this is not a simple question to answer since the quality of wheat is influenced by season and environment. Nevertheless, the National Institute of Agricultural Botany has recently issued a report giving broad recommendations based on the results of trials carried out over a long series of years.

In 1941 and particularly in 1944, a further problem arose. The weather at harvesting was unusually wet, and as a result much of the wheat sprouted in the field. As is well known, the effects of sprouting on the commercial value of a wheat crop are serious. Not only is the grain useless for seed, but also its value for milling purposes is greatly impaired. The enzymes produced during germination reduce the baking quality of flour, giving rise to undesirable characteristics in dough and bread which cannot be rectified by treatment. The diastatic activity of a wheat (normally expressed as the 'maltose figure') is a measure of the extent of germination, and in an effort to lessen the damaging effects of sprouted home-grown wheat the Ministry of Food issued instructions that no wheat must be used with a maltose figure exceeding 3 per cent. Even so, this type of damage in varying degree has been evident in much of our bread—the crumb is doughy and the loaf cuts badly—and in routine surveys of the quality of commercial bread during November and December last, as much as 25 per cent of the bread was affected.

The ease with which a freshly harvested seed germinates is linked up with the extent to which it shows dormancy, some seeds will only germinate after a prolonged period of dry storage. The phenomenon has received attention from several investigators, notably Harrington¹ and Crocker². Crocker

has pointed out that most species of wild seed can show a very prolonged dormancy which serves as a natural protection for the preservation of the species. In cultivated varieties the phenomenon is far less evident but still persists in varying degrees. The frequent occurrence of dormancy in home-grown new crop barley, especially in the colder and damper north of Britain, is well known to maltsters, who find it necessary to dry such grain in a kiln and store it over a period of weeks or even months to secure the rapid and even germination essential to their process. Bishop³ has also recently recalled the observation of Duchartre⁴ on the variations of the germinative energy of barley at, and about, harvest time. Duchartre noted that while barley grain in the milk stage was capable of germinating readily under suitable conditions, upon ripening the power of rapid germination steadily diminished, passed through a minimum, and thereafter improved to a maximum from which it was very slowly reduced with age. It is, therefore, usual to distinguish the ripe stage of barley, at which it is ready for harvest, from the so-called mature stage at which it is able to germinate readily, and the recovery process is termed 'maturation'. The length of the dormancy period and the rate of maturation are usually considered to be a function of the conditions of temperature and moisture content in which the grain finds itself, a warm, dry condition hastens maturation, and conversely cold and damp retard it. However, in any sample of dormant grain, representatives of all stages of dormancy are usually to be found, hence germination tests show uneven response with time, and are, of course, liable to considerable sampling error.

Little attention has hitherto been paid to the study of dormancy in English wheat. In general, it appears to be less evident than in barley, though from our own observations it follows a similar course. During the past season, we have been fortunate enough to obtain from Rothamsted Experimental Station samples of both Als and Vilmorm wheats during seven weeks covering a period immediately prior to and following upon the cutting of the crop. Many grains of the earliest samples when first removed from the ear and planted showed rapid germination, a capacity which they lost almost entirely after a short period of drying in the sun. The later samples of wheat showed pronounced dormancy but with gradually increasing recovery which was almost complete in the last sample. By this time grain from the first sample, which had been stored air-dry in the laboratory, had also matured. It is clear that the tendency of grain to sprout during harvest will depend not only on the atmospheric conditions but also on its state of dormancy. When hot dry weather, which will hasten maturation, is followed by rain, conditions are most favourable for sprouting, in a cold damp season grain is likely to show less tendency to sprout in a rainy harvest. It must, however, be realized that if favourable conditions prevail for a sufficiently lengthy period, even very dormant grain will eventually germinate unless some external agency such as mould intervenes to make an end.

During the past harvest season, we have been able to carry out a preliminary investigation on the degree of resistance to sprouting exhibited by several varieties of wheat. By the kindness of Mr H. W. Gardner, Hertfordshire Agricultural Institute, we were able to examine samples of nine wheat varieties grown, with and without nitrogenous supplement, side by side on three different sites selected for

differences of soil condition. On the first of these sites the crop had been cut, stooked and carried in good weather and had escaped sprouting. On the other two, harvest conditions had been by no means so good, wet weather causing a degree of sprouting in several instances. Weight percentages of sprouted grain separated by the hand-picking of sub-samples weighing not less than 80 gm are set out in the following table.

Variety	Percentage sprouted grain			
	Site II		Site III	
	No nitrogen	Nitrogen added	No nitrogen	Nitrogen added
Holdfast	39.7	24.4	27.1	26.8
Steadfast	42.6	48.6	34.0	19.9
Julana	30.1	25.8	7.8	12.2
Squarehead's Master	18.1	16.7	4.1	1.6
Scandia	17.6	7.3	4.2	2.3
Weibull's Standard	3.8	8.4	1.0	1.2
Desprez 80	19.7	23.0	1.7*	0.5*
Vilmorm 27	2.9	0.9	4.1	6.1
Little Joss	6.1	6.4	2.6	4.0
Total average	20.05	17.95	9.6	8.3

* Desprez 80 from Site III was immature and thus very dormant, as with unripe grain after sun-drying. Results for Site II are probably a truer indication of the tendency of this variety to sprout.

These results indicate, as might be expected, that nitrogenous manuring has no substantial influence on the dormancy period of wheat, the small differences shown in the table being probably adventitious. On the other hand, as between varieties, Holdfast, Steadfast and Julana seem especially prone to sprout, a tendency accentuated on Site II where harvest conditions were even more severe than on Site III. Squarehead's Master seems to occupy an intermediate position, while Little Joss, Weibull's Standard and Vilmorm 27 appear to be much more resistant. This conclusion has been to some extent confirmed by the examination of isolated individual samples from other sources, which suggest that while soft white wheats such as Wilma and White Victor sprout readily, Als, Atle, Iron II, Redman, 60 and Bersée are resistant.

Further confirmation of some of our findings has been communicated privately to us by Dr Hunter, of the National Institute of Agricultural Botany, who has noted that during the harvest of 1944 sprouting trouble was especially prevalent in Holdfast, Steadfast and Julana.

It has to be admitted that our data are at present insufficient to decide as between varieties on their relative dormancy periods. It is hoped, however, to obtain such information during the next season. In considering the preliminary data, it has to be remembered that all varieties were reaped and carried at the same times, and hence the earlier ripening varieties have been exposed to a more severe test. As regards breadmaking quality, it is disconcerting to find that the majority of the resistant wheats are generally thought to be poor. On the other hand, it has recently been suggested by Johnston^{5,6}, and by Harrington and Knowles⁷ that dormancy may be an inherited character. If such be true, it should offer possibilities to the plant breeder, and in fact, in the case of barley, Freistedt⁸ has already directed attention to this.

The general problem would appear to be one of some importance if we continue to grow wheat in Britain for bread-making.

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⁶ Johnston, L. P. U., *Can. J. Res.*, 13 C, 283 (1935)

⁷ Harrington, J. B., and Knowles, P. F., *Sci. Agric. Ottawa*, 20 (6), 355 (1940)

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UNIVERSITY REFORM IN BRITAIN

By DR. RAYMOND PRIESTLEY

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UNIVERSITY reform is in the air to-day. The amount of discussion about the future of higher education that is going on among thinking people—and to-day a greater proportion of citizens are thinking than usual—cannot but do good. Isolationism—the 'ivory tower' conception of the role of the university—has always been liable to become a limiting factor in its usefulness.

The National Union of Students has recently discussed the subject, and has issued a report*, the chief characteristic of which is its entire reasonableness. One somehow expects student opinion to run to extremes, usually to the Left. It would indeed be unnatural if youth were satisfied with the present condition of affairs. But all the suggestions put forward here are in my own opinion worthy of thoughtful consideration by university authorities.

Here, as elsewhere, the abolition of fees tends to become a fetish or King Charles' Head. Education for all who are worthy to the limit of their need and powers is a first-rate end, but I do not believe that, in our present state of society, abolition of fees is the best means to that end. Nor is it likely to be for some time. There are very many people to-day who can afford to pay for their university career. Many find pride in doing so. Unless we drastically change our methods of selection—getting away from the purely intellectual sieve—we should, if we exclude fee-paying students, lose a valuable element of student life. Oxford and Cambridge in particular have benefited from the leavening influence of many men who would not have reached a university on intellectual qualifications alone, and no one has benefited more from their presence than the scholars themselves.

Also, while our society is so constituted that men exercise influence more than the average through accident of birth and wealth, it is good that they should, as part of their education, live in a university atmosphere for some years. Again, government is not yet so conditioned that the universities would not be financially crippled if fees were eliminated from their income. First we need the Government and local authority grants doubled and doubled again. I am therefore against the abolition of university fees. The time is not nearly ripe. What would be the value of flooding impoverished universities with students for whom we cannot cater properly, while excluding men and women all of whom to-day have to prove their intellectual fitness for university education through entrance examination, many of whom select themselves on other grounds better than some scholars, and most of whom, as society is organized to-day, are going to play an important part, and should have the best possible preparation. The abolition of fees in universities might be a proper and necessary feature of a social revolution, but as an incident of university organization to-day it is premature and out of place. Let us, on the other hand, have more generous maintenance allowances and more scholarships. Most of our anticipated expansion in numbers should derive from that source.

The need for, and value of, a high standard of character and personality as well as intellect in university personnel—be they staff or students—make the more important one recommendation that I can heartily endorse: compulsory residence for one year at least. I would go further and ask for two as a minimum. It is a debatable point whether, if only one is required, the freshman year is the best. Different colleges at Oxford and Cambridge hold different views about this.

An interesting point raised is the question of student representation on university governing bodies. At the University of Birmingham students are represented on the Court. This is a good thing, but it means very little in practice. At the University of Melbourne they are represented on the Council. That was never an embarrassment to the University during my tenure of the vice-chancellorship, and I do not believe it had been before. What the National Union of Students means by direct access to council, senate and faculties is not clear, but I do not believe any such body would refuse to see a deputation of students if asked, certainly not in any university on the staff of which I have served. I agree, however, with the Union that the most promising method of integration is through staff-student committees. I think few heads of departments, if properly approached, would refuse to participate in such discussion groups. A good example of this sort of co-operation is the Arts Council at the University of Birmingham.

The revolt against over-lecturing is natural, but can, I think, be overdone. Spoon-feeding would be as bad as under-nourishment. Let us have more seminars and informal tuition by all means. I have tried out the cyclostyled notes idea, and on the whole it was not a success. It was useful occasionally for broadcasting diagrams or charts, or especially difficult arguments, but used as a general rule it made for slackness and inattention, at least in some subjects and with certain types of students. I can imagine, however, that the issue of regular notes might be valuable in certain subjects. Personally, I would rather have students stay away and read than be compelled to attend lectures in which they are not interested. In this, as in many other things, however, a vice-chancellor carries less weight than professors, and he must defer to their specialist knowledge of teaching.

For the rest, a vigorous student union, as autonomously governed as possible, is an essential requisite for satisfactory life in the non-residential university. The sad thing to-day is the fact that the educative influence of the union is confined to a minority of students. The majority use the building only as a restaurant, lounge and dance hall. Only student opinion and student influence can remedy this. Many never go near the union at all. They are the 'brown baggers' of whom we hear so much. The only answer to them is compulsory residence in halls of residence generously equipped with a staff whose interests are student-centred, and with the amenities that foster community spirit and social activity.

I would agree with the estimate that student numbers in British universities should be increased over all by 50 per cent, though, since Oxford and Cambridge are near saturation point, this will mean doubling the size or number of the provincial universities. The remarks made about the curriculum are well worth study by university senates, which are, indeed, not unaware of the need for reform.

* The Future of University and Higher Education: a Report prepared by the National Union of Students of the Universities and Colleges of England and Wales. Pp 16 (3 Endsleigh Street, London, W C1, 1945) 6d.

Many faculties are vigorously discussing these questions now

Nearly all the proposals in what is a useful and provocative little booklet mean greater expenditure. We must hope that those who hold the purse-strings will realize that to-day the universities are a long way behind scratch. The greater part of the first increases of grant will be expended in bringing us back into line for a good start after the backsliding made inevitable by six years of war.

It has been difficult to review the report issued by the National Union of Students in a short article—it is quite impossible to do justice to the many subjects touched upon at the Second Educational Conference of the Association of Allied Professors and Lecturers, held in London on April 14, 1944, the proceedings of which are now available*. Mental indigestion and a seething mind are inescapable after a first reading. There are, however, some impressions that pick themselves out. The modern Soviet university seems to have got farthest from the 'ivory tower' idea, but this has been incidental to profound social and political changes. Unless we are prepared to follow them in the larger field—and I for one think that we should lose more than we should gain by doing so—we must seek to attain the same end by more devious ways. The United States are trying hard to achieve an educated democracy and have had a measure of success. It has been easier in a country with an expanding frontier than it has been in overcrowded Western Europe with its bounds set by history and tradition. It will be less easy in the America of the future, when the expanding frontier will be a memory of the past. When I visited the United States in 1936, the Federal Government was spending sixty million dollars a year on student maintenance, because it was becoming progressively more difficult to work one's way through college in competition with the regular labour force.

I like Sir Fred Clarke's definition of training as "the cutting edge that makes education specifically

serviceable". General acceptance might give the word and idea a new lease of respectable and useful life. Interchange on the Franconi chair scale, with its fully equipped laboratory and specialist assistants for the visiting professor, approaches the ideal, and is linked in my mind with the good idea of occasional interchange between the professor and master of the school sixth form. The greatest professors like taking elementary classes despite what Bruce Truscott says. It is not too great a step to go back to school, though the step would certainly be new. The American system of sabbatical leave and the junior's *wanderyahr* have done much for peaceful penetration into China, and the British Commonwealth might well emulate their trans-Atlantic cousins here. Of the great university dangers, 'specialization, mechanization of learning, and interference by the State', we in Britain know something of the first two, but we have steered clear of the third thanks to our genius for anomalies in our government set-up. Long may that remain true.

Sir Ernest Barker has likened the ancient universities to mountains of ice nine-tenths submerged in seas of history and tradition. Having had experience of Antarctic exploration, I am tempted to carry the analogy a step further. The new universities are more like the snowbergs from the Antarctic continent with half their bulk above water. They may have a more workmanlike façade, if a different one. They are without the peaks and pinnacles, but there is something to be said for a solid rectangular shape. They are more responsive to the winds of public opinion. They are more readily adaptable to the social environment in which they are set. These are, on balance, not bad characteristics. I will not press the analogy too far, for icebergs and snowbergs alike, when they grow older, pass through the stage of being hidden dangers to navigation; and finally they disappear leaving no trace.

* Association of University Professors and Lecturers of the Allied Countries in Great Britain. Second Education Conference, April 15, 1944. Some Comparisons between Universities. Pp xvi+64 (Oxford: Basil Blackwell, 1944) 2s 6d net.

NEW FELLOWS OF THE ROYAL SOCIETY

The following were elected fellows of the Royal Society on March 14.

MR L. COLEBROOK, a member of the scientific staff of the Medical Research Council. Distinguished in the application of bacteriology to clinical medicine, he played a leading part in the practical establishment of the 'sulpha' drugs, and has thrown much light on the fevers of childbirth. During the War he has directed important investigations on burns.

MR W. S. FARREN, aeronautical engineer, director of the Royal Aircraft Establishment, Farnborough. He has been associated with aeronautical research and development continuously since 1914, and has contributed greatly to advances in the science and practice of aeronautics.

DR N. FEATHER, lecturer in physics in the University of Cambridge, distinguished for investigations which have added much to knowledge of the spontaneous and induced disintegrations of atomic nuclei.

PROF J. H. GADDUM, professor of pharmacology in the University of Edinburgh, distinguished for his work on the identification and estimation of acetyl-

choline, adrenaline and histamine in animal tissues and for his experimental contributions to the conception of cholinergic and adrenergic nerves.

DR H. GODWIN, lecturer in botany in the University of Cambridge, distinguished as a plant ecologist, and especially for his contributions to the knowledge of the post-glacial history of British vegetation based on the pollen analysis of recent deposits.

PROF J. M. GULLAND, Sir Jesse Boot professor of chemistry, University College, Nottingham, distinguished for his analytical and synthetic work in the phenanthrene group of alkaloids, and for his work in the development of the chemistry of substances of biological importance.

MR H. W. HARVEY, marine biologist, distinguished for his contributions to our knowledge of the 'productivity of the sea' by co-ordinating the varied factors, physical, chemical and biological, which determine it.

PROF V. C. ILLING, professor of oil technology in the Imperial College of Science and Technology, distinguished for his researches on the relation of texture of sediments to oil accumulation, and for

refinements of stratigraphical and geophysical methods applied to interpret the structure of oil-bearing lands.

MR A E INGHAM, University lecturer in mathematics in the University of Cambridge, distinguished for his researches in pure mathematics, particularly in the theory of numbers

PROF H D KAY, director of the National Institute for Research in Dairying, distinguished for his biochemical work, particularly for his investigations upon organic phosphorus compounds and the phosphatases. Recently he has applied his methods to the practical problems of dairying

DR. W B LEWIS, lecturer in physics in the University of Cambridge, distinguished both for his contributions to the investigation of the structure of atomic nuclei and also to the development of the science of electronics, with special relation to ultra-high frequency radiation.

DR KATHLEEN LONSDALE, physicist, Royal Institution, distinguished for outstanding contributions to the investigation of the crystalline structure of organic compounds by means of X-ray analysis. Particularly important have been her recent researches into the fundamental mechanics of crystal structure.

PROF P C MAHALANOBIS, professor of physics, Presidency College, Calcutta, and founder of the Statistical Laboratory, Calcutta; distinguished for his contributions both to statistical theory and to the applications of statistics, particularly to sample surveys, agriculture and population

PROF R E PEIERLS, professor of applied mathematics in the University of Birmingham, distinguished for his contributions to theoretical physics, particularly in the application of quantum mechanics to the electron theory of metals and other phenomena of the solid state, and in the theory of the atomic nucleus.

PROF J MONTEATH ROBERTSON, Gardiner professor of chemistry in the University of Glasgow, distinguished for his work on crystal structure by the methods of X-ray analysis. He has made measurements of great accuracy in this field, and has derived from them precise molecular structures, electron density distributions, and inter-atomic distances of organic molecules

PROF F M ROWE, professor of colour chemistry and dyeing in the University of Leeds. As leading dyestuff technologist, his work has been of national importance. He has made varied and original contributions to the chemistry of dyes and intermediates.

SIR WILLIAM WRIGHT SMITH, King's botanist in Scotland, regius keeper of the Royal Botanic Garden, Edinburgh, and regius keeper of botany in the University of Edinburgh, distinguished for his contributions to the taxonomy of Angiosperms, and especially for his monographic treatment of the genera *Primula* and *Rhododendron*.

MARJORY STEPHENSON, a member of the scientific staff of the Medical Research Council, distinguished for her biochemical researches upon the metabolism of bacteria, which, with those of her pupils during twenty-five years, have included work upon hydrogenase, lactic dehydrogenase and adaptive enzymes

MR B N. WALLIS, mechanical engineer, chief of research and development of Vickers-Armstrong Ltd, Aircraft Section. He has been responsible for many new projects of design, and his work has led to secret developments which have been of great importance in the war effort

MR. J. Z. YOUNG, lecturer in zoology in the University of Oxford, distinguished for his outstanding contributions to knowledge of the nerve fibre, both of its structure and function. During the War he has worked on important clinical aspects of the repair of damaged nerves

NEWS and VIEWS

Prof. Guido Castelnuovo

MATHEMATICIANS will be pleased to learn that Prof Guido Castelnuovo, formerly professor of geometry in the University of Rome, is safe and well. In a recent letter to Mr L Roth, of the Imperial College of Science and Technology, London, he relates that he, with members of his family, obtained refuge during the German occupation of Rome, and that he has now returned to his well-known house in the Via Boncompagni. Castelnuovo is eighty years old this year; the world of science will unite in congratulation. Castelnuovo's work (which was reviewed in *Nature* of December 10, 1938, p 1016) represents the best in Italian geometrical thought over a long period. Born in an age which, to quote his own phrase, "closed one epoch and opened another", his first papers were, naturally enough, on the projective geometry of higher space. But soon, with Corrado Segre, he was making essential contributions to the algebraic geometry of curves which, sixty years ago, was beginning to assume its modern form. Then, in 1894, with Federico Enriques as his collaborator, he initiated the study of the algebraic geometry of surfaces, on no firmer a foundation than the hints and conjectures (some of them mistaken) of Max Noether. Much of this work is definitive, in a negative as well

as in a positive sense, for where he has paused, his successors in the field have often found it impossible to progress. Perhaps the most celebrated of Castelnuovo's papers is the memoir of 1896, in which he gives necessary and sufficient conditions for the rationality of a surface, that is, for the existence of a one-to-one algebraic correspondence between the points of the surface and those of a plane. Incidentally, this was quite literally a piece of research, in that the author did not suspect what the conditions were before he began to write the paper. So the theory of rational surfaces was able to take its place by the side of the classical theory of rational curves.

Already (and, in fact, during the previous ten years), Italian geometers were posing similar questions for the threefold, that is, the locus which is represented analytically by an equation in four co-ordinates. The quadric threefold, like the quadric surface, is easily seen to be rational by projecting the locus from a point of itself. It was also well known (though the proof is less obvious) that the general cubic surface is rational. The question now arose, what could be said about the general cubic threefold? The question was destined to become one of the historic problems of geometry. At first glance one could see that the answer would either be imme-

diate or else very difficult to obtain. A first attempt fell wide of the mark. Segre, in his great work on cubic threefolds, written about 1887, had tried to grapple with the problem, but it turned out that the varieties he considered, though rational, were not general of their type. The problem was then taken up by Prof Gino Fano, of Turin, one of Castelnuovo's first pupils. In a struggle which has lasted some fifty years, Fano has made vital contributions to the subject, culminating last year with the news, in a letter from Switzerland, that he had succeeded in showing that the general cubic threefold is irrational. It would be an under-statement to say that geometers await with impatience the appearance of Fano's investigation.

Miss P. M. Taylor

MISS P. M. TAYLOR, who has recently been appointed woman educational officer to the Central Council for Health Education, was educated at Girton College, Cambridge, and Westfield College, London. Miss Taylor joined the executive committee of the Association of Women Science Teachers in 1932, and in 1935 was elected honorary general secretary, in which capacity she served until October 1944. Her new position with the Central Council is an important one which necessitated her relinquishing the onerous duties of the general secretaryship of the A S W T, though she was re-elected to the Executive Committee this year. The present investigations of the Association, which have already resulted in the publication of the pamphlet "Pre-Nursing Course in Schools" (1943) and the Interim Report on Science in Post-Primary Education (1944), are in a large measure due to the initiative and exceptional powers of organization of Miss Taylor. The Association is fortunate in having her continued co-operation in the completion of this work, the results of which it is hoped to publish shortly. Miss Taylor's zeal is unabated, in spite of the calls made upon her and her capable assistants during the war years to keep in touch with the members. Their success is seen in the vigorous growth in membership and the widespread interest in progressive methods of science teaching, which factors have necessitated the appointment of a full-time secretary. In addition to her work as honorary general secretary, Miss Taylor has served on the Education Advisory Committee of the Central Council for Health Education, the Consultative Committee to the Nursing Reconstruction Committee, Royal College of Nursing, and as president of the Essex Branch of the A S W T. She held the post of senior science mistress at the Southend-on-Sea High School for Girls until July 1944.

Agricultural Zoology in Scotland

DR D. S. MACLAGAN, lecturer in zoology at King's College, University of Durham, has been appointed head of the Department of Zoology of the West of Scotland College of Agriculture, Glasgow, and research advisory officer in agricultural zoology for the south-west of Scotland, in succession to Prof L. A. L. King, who has retired. Dr MacLagan held a Ministry of Agriculture research scholarship during which he carried out work at the Parasite Laboratory of the Imperial Bureau of Entomology and at Harvard University, and later worked with a Carnegie research fellowship at the University of Edinburgh. He is known for his work in animal ecology and on the dynamics of animal populations.

Cosmic Ray Investigations in Armenia

THE preliminary results of the Alagez Expedition of 1944 for the study of cosmic rays have been published in the U S S R. Observations have been made each year since 1942 from a camp on Mt Alagez in Armenia at a height of about 10,000 ft above sea-level. All instruments, supplies and camp equipment had to be carried on pack animals. As conditions are extremely favourable for the study of cosmic rays, it has now been decided to build a permanent station there, with an observation post at about 13,000 ft. It is now believed that cosmic rays contain a third element in addition to mesotrons and electrons. The particles which make up this third element have a greater ionizing effect on air than either mesotrons or electrons. The latest expedition spent three months in attempting to discover the nature of this third component, especially the mass of the particles of which it is composed. The difficulty was to separate them from the other already known components. New methods were evolved, and some new and extremely sensitive instruments built. The particles were found to have properties very similar to those of protons. The part they play is apparently more significant than was at first realized. Only preliminary data, however, have been obtained, and the material is still being studied. The expedition made several thousand observations during great cosmic ray showers for the purpose of determining the energy of the cosmic particles which cause the showers. It was found to be enormous. A special kind of shower, occurring over a very small area, but including a tremendous number of particles, was also discovered.

Stone Age Implements in India

INDIA is rich in relics of Stone Age man, and the prehistorian there has a wide field for research. Not a great deal of new information will be gleaned from "Pre- and Proto-history of Gujarat" (H. D. Sankalia, reprinted from "The Glory that was Gūrjaradesa", 1943), though the gazetteer of finds at the end of the article is useful so far as it goes. What the prehistorian asks from researchers in the field in India is definite stratigraphical data. Perhaps, therefore, the geological section of the right bank of the Sabarmati River at Pedhāmli appearing on p. 15 is the most important single item in the article. It would seem that, as throughout Madras, early Stone Age artefacts come from a gravel conglomerate which rests immediately upon laterite. The occurrence of a microlithic industry suggests that its makers were using composite tools in which several 'pigmy' flints were hafted together to form one efficient instrument. Such industries appear at various different periods when natural circumstances permit or encourage their development and may be of widely different ages, and one must enter a caveat against the wisdom of trying to correlate the microlithic finds of Gujarat with those of Europe. In India itself, Colonel Gordon, in "Indian Art and Letters" (1936), has shown that the rock-shelter paintings in the Mahadeo Hills are not very old—maybe first century B.C. to tenth century A.D. in date. There the only industries found in the rock-shelters below the paintings consist of typical Indian pigmy artefacts. Near the surface a little pottery occurs, in lower levels this is absent. The conclusion would seem to be that the pigmy industries themselves are not very old and certainly nothing to do with the European Mesolithic either culturally or in time. This is also true of the numerous

microlithic industries in quartz found in Ceylon. Dr Sankalia ("The Second Gujarat Prehistoric Expedition A Preliminary Account of the Search of 'Microlithic Man in Gujarat,'" by H D Sankalia and I Karve, *New Indian Antiquity*, 7, No 1, April 1944) has described the unearthing of some skeletons, believed to belong to the folk who made the pigmy objects described. Physical anthropologists will naturally await with interest a complete account of these finds when the final study of them has been made.

Community Centres

THE report on community centres recently prepared by the Ministry of Education (Pp 40 London H M Stationery Office 9d net) is a document of much importance. The Government has decided that the provision of such centres to promote the social and physical training and recreation of the community should be regarded as coming within the scope of the education service administered by local education authorities, such provision being covered by Section 53 of the Education Act, 1944, without prejudice to the power of other local education authorities under Section 4 of the Physical Training and Recreation Act, 1937, to provide centres for athletic, social or educational objects. Arising out of that decision, this report has been prepared at the instance of the Minister of Education by some of his officers, and is now published for general information. The first chapter of the report goes at once to the root of the matter. "During the present century, the day-to-day life of the British people has been profoundly affected by two parallel and closely related developments—the mechanisation of industry and a progressive reduction in working hours. The reduction in working hours may have been largely due to the growing demand for more leisure, but it was mechanisation which made it possible to meet the demand". That is the point of departure taken in this searching and comprehensive report, that, and another fact plain to be seen, that it is one thing to have spare time and another to know how to use it wisely. Though the report does not expressly say so, it means that we have reached a position in which the twofold distinction between work and leisure should be replaced by a threefold distinction between (1) work, done for a living, whether one likes it or not, (2) relaxation, play, recreation, for the recovery of poise, and (3) true leisure, spent upon pursuits which may make it in one way or another "the growing time of the spirit". In subsequent chapters the report goes into detail about the organization, staffing, provision and maintenance, and ownership, control and management of community centres. A valuable appendix sets forth the suggested accommodation required for neighbourhood units in varying situations.

Control of Rabies

In an interesting leading article, the *Lancet* (628, Nov 11, 1944) directed attention to the need for the existing regulations designed to prevent the reintroduction of rabies into Great Britain. The law requires that all dogs imported, by air or otherwise, shall be quarantined for six months; strict insistence on this regulation would prevent the reappearance in Britain of this serious disease. Rabies is primarily a disease of dogs, cats and allied species, but it is communicable to man and to domesticated animals by the bite of a 'mad' dog. It was first recorded in Great Britain in

A.D. 1000, but it probably existed here before that date. In the middle of the eighteenth century it raged among dogs in London and elsewhere. In the nineteenth century it broke out among several packs of fox-hounds, and some thirty-six persons a year died of rabies. By 1902 rabies had been eradicated from Great Britain by stringent control measures, and it did not reappear for sixteen years. By then (see Stockman, S, *Vet Record*, 32, 135, 1929, quoted by the *Lancet*, loc cit) the public was so unfamiliar with the disease that some sections of it failed to realize the dangers of its reintroduction, and the abnormal conditions of that time doubtless helped its spread.

Rabies was found among dogs in Great Britain in September 1918, the infection having been brought in by smuggling dogs into the country by air. The Ministry of Agriculture took energetic measures against it, and these measures were helped by the fact that most of the dogs were affected by the dumb or paralytic form of the disease, which greatly restricts their wanderings and ability to bite, and also by the fact that the disease broke out in Cornwall, which is isolated to some extent from the rest of England, most of the affected dogs wandered west to the sea. Nevertheless, some seventeen counties became involved, 327 dogs died of the disease and 368 human beings were bitten and had to be treated. The outbreak was not controlled until December 1921 (see *Lancet*, 11, 719, 1926). In the United States, during the last ten years, there has been an average of fifty-seven cases a year, and some States have recorded more than a thousand cases a year among animals. Rabies vaccines are available, and the *Lancet* (628, Nov 11, 1944) discusses the value of these, which has been questioned. Meanwhile it cannot be too widely known that rabies will, if it comes again to Great Britain, cause much suffering among men and animals. The quarantine regulations, which can keep rabies out of the country, should therefore be vigorously supported.

Stars or Planets?

PETER VAN DE KAMP has an article with this title in *Sky and Telescope* of December 1944, in which he deals with the question of the criterion for stars and planets—a matter of considerable importance in view of the fact that recent discoveries have shown the existence of 'planets' fifteen or twenty times the mass of Jupiter. He accepts Russell's critical value of 1/20 of the sun's mass as a conventional borderline between visible stars and the invisible bodies which can be designated as 'planets'. This criterion defines a planet or star, therefore, by its mass, not by its size. Among the methods for detecting unseen companions of low mass is the photographic method applied to nearby stars, and if the determination of the orientation of the perturbation orbit were sufficiently accurate, good results would be obtained. Difficulties arise from the fact that photographic star images are 1"-3" in diameter, and most of the recently discovered perturbations have a total amplitude of less than 0.1". The gravitational method for discovering faint companions of low mass, while it is more powerful than the direct visual approach, has decided limitations for very low masses, and it would be extremely difficult by this method to find companion masses less than 1/100 times the sun's mass, even for the nearest stars. The star which seems unattended by dark companions may be the exception, and it is possible that the stars attended by massive companions, rather than by small planets,

are in the decided majority. Our solar system may prove to be an extreme type of system, rather than an average type. Though generously endowed with planets, the sun is the only star known that has no close companion star.

Optical Phenomena in the Atmosphere

L/CPL V S TAYLOR, 6 Field Park Coy., R.E., C.M.F., writes "The discussion on optical phenomena in the atmosphere in *Nature* of December 9, 1944, brings to mind an occurrence frequently witnessed at Anzio while it was a beachhead. During, and immediately after, intense A.A. fire under conditions of virtually clear sky, with the sun behind the observer, concentrically disposed wave ripple arcs could be seen passing away from the barrage zone, in the portion of the sky about 45° forward of the observer. The acute compression of the atmosphere peripheral to the bursting shells caused the compression zones to be sufficiently altered in refractive index to produce an optically visible phenomenon when refracting undiffused sunlight." This phenomenon would seem to be similar to the concentric waves observed by Dr A. H. Goldie following a bomb burst (*Nature*, 154, 738, 1944).

Post-War Bread in Britain

THE Ministry of Food, in collaboration with the Health and other Departments interested, has arranged a conference with the industrial and trade organizations principally concerned with post-war bread. It is hoped that the discussions of the conference will assist the Departments in advising Ministers on post-war flour and bread policy and in particular on any regulations which may have to be made after war-time control ends. The milling and baking industries, the flour importing trade and the co-operative movement have been asked to nominate representatives to the conference, invitations will be addressed to other interests later as may be necessary. The conference will be attended by the Lord Horder (personal adviser to the Minister of Food on medical aspects of food problems), Sir Jack Drummond (scientific adviser to the Ministry of Food), Sir Wilson Jameson (chief medical officer of the Ministry of Health), Dr Andrew Davidson (chief medical officer for the Department of Health for Scotland) and Sir Edward Mellanby (secretary of the Medical Research Council). In addition, there will be present administrative officers representing the Ministry of Food, the Ministry of Agriculture and Fisheries and the Ministry of Health. Sir Henry French, the permanent secretary of the Ministry of Food, will be the chairman of the conference.

Agricultural Scholarships

THE Ministry of Agriculture and Fisheries invites applications for ten senior scholarships, tenable at university departments of agriculture, or agricultural colleges, for degree or diploma courses in an agricultural subject, or at veterinary colleges for courses in veterinary science, and for six extended junior scholarships (for those who have already held junior awards), and sixty junior scholarships, tenable at farm institutes or similar institutions, for courses not exceeding a year, in agriculture, horticulture, dairying or poultry husbandry. The scholarships are open to the sons and daughters of agricultural workmen or of working bailiffs, smallholders and other rural workers, and to persons who are themselves *bona fide* workers in agriculture. The value of the awards

is such that neither the recipients nor their parents are normally required to make any contribution towards the cost of the training provided. The usual method of selection is by interview. Full information concerning the scheme and forms of application may be obtained from the Secretary of the Ministry, Block 4, Bickenhall Mansions, Baker Street, London, W 1, or from the offices of County Councils. The latest date for submitting applications is April 30, 1945.

The Night Sky in April

NEW moon occurs on April 12d 12h 29m U.T., and full moon on April 27d 10h 33m. The following conjunctions with the moon take place: April 9d 19h, Mars 3° N., April 17d 13h, Saturn 0 1° N., April 23d 06h, Jupiter 3° S., April 26d 18h, Mercury 6 3° S. Only one occultation of a star brighter than magnitude 6 takes place in April, namely, 8 Leon, which disappears on April 21d 1h 29 7m. Mercury sets at 20h 11m at the beginning of April and rises at 4h 10m at the end of the month, about 25 minutes before sunrise. The planet is in inferior conjunction on April 13 and is stationary on April 3 and 25. Venus is a conspicuous object in the western sky in the early portion of the month, setting at 21h. on April 1. On April 30 the planet rises at 3h 35m, an hour before sunrise. Venus is in inferior conjunction on April 15. Jupiter is visible throughout most of the night, setting at 5h 13m and 3h 14m at the beginning and end of the month, respectively. Saturn can be seen in the early portion of the night, setting at 1h 49m and just after midnight at the beginning and end of the month, respectively. The Lyrid meteors are active during April 18-22, but moonlight will interfere with the observation of the shower.

Announcements

WE regret to record the death on March 23 of Sir Napier Shaw, F.R.S., the doyen of British meteorologists, aged ninety-one.

BOTANISTS will be pleased to learn that Mr E. J. H. Corner, assistant director of the Botanical Gardens, Singapore, who has been in the hands of the Japanese since the fall of Malaya is, according to a cable received from him, "well, happy, working as a botanist."

DR THOMAS A. JAGGAR, the well-known volcanologist, has been awarded the Franklin L. Burr Prize of 1,000 dollars by the National Geographic Society. The Prize, established under a bequest of the late Mary C. Burr of Hartford, Connecticut, provides for cash prizes to members of the Society's expeditions considered to have done especially meritorious work in the field of geographical science. The award was made to Dr Jaggar for his part in the development of an amphibian mobile boat in 1927, which was used by a National Geographic Society expedition headed by Dr Jaggar to carry on researches in Alaska in the region of Pavlov Volcano during 1927-28.

A COURSE of twelve lectures in special librarianship has been arranged by the Association of Special Libraries and Information Bureaux, and will be held at the London School of Hygiene and Tropical Medicine, Keppel Street, Gower Street, London, W.C.1, at weekly intervals starting on April 18, at 4.30 p.m. Applications to attend should be sent to the General Secretary, ASLIB, 52 Bloomsbury Street, W.C.1, as soon as possible, the fee is £5 5s. for the course.

LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications.

✓ Age of the South African Ape-men

THE determination of the age of mammalian fossils of the later Tertiaries is a matter of the greatest difficulty. In America, Pliocene land beds are rather rare, and except in Europe where we can divide the Pleistocene by its Ice Ages, the classification of the Pleistocene is also very difficult. We have had many different views of the ages of the Siwalik deposits by Falconer, Lydekker, Pilgrim and Matthew. In South Africa we are in much greater difficulty as the majority of our mammalian fossils are not nearly related to those of Europe or Asia, and are even less related to those of America.

The determination of the age of the caves which have yielded the skulls and remains of the Australopithecines or ape-men is a matter of very great importance, as these Primate fossils show remarkable affinities to man. If they are Pleistocene they were contemporaries of man, though probably survivors from a family from which man arose in the Pliocene. If they are Pliocene they may be nearly related to the ancestor of man, and *Australopithecus* — the Taungs ape-man — may be so near to ancestral man as to be practically the 'missing link'.

At Kromdraai true horse (*Equus*) teeth are abundant. There is a large horse and a small one, so we may consider the Kromdraai ape-man *Paranthropus* as belonging to some part of the Pleistocene.

The Sterkfontein ape-man *Plesianthropus* is certainly of a very different age. No species of mammal is known from both Sterkfontein and Kromdraai except perhaps two species of the rats of the genera *Mystromys* and *Otomys*. The 'baboons' are different, the jackals are different, and so are the dassies. Further, no horse teeth are known from the Sterkfontein cave, though they have been found only 150 yards away. As a porcupine occurs which does not seem to differ from the living species, I thought it safer to keep *Plesianthropus* in the Pleistocene, though the presence in the cave of two species of sabre-tooth cats seemed to point to the deposit being old; but there was always the possibility of sabre-tooths surviving into Pleistocene in South Africa after they had died out in Europe and Asia.

The Taungs ape is manifestly much older than those others. The associated fauna is quite unlike that at Sterkfontein or Kromdraai. I, therefore, provisionally placed the Sterkfontein and the Kromdraai ape-men in Middle Pleistocene, and the Taungs ape-man in Lower Pleistocene, though not improbably belonging to Upper Pliocene.

I have just had given me a few days ago by the

Abbé Breuil the snout of a primitive hyæna. This was found by Dr H. K. Silberberg at Sterkfontein three years ago. I have seen Dr Silberberg and find that he picked up the specimen in the lower part of the Sterkfontein cave. The spot is almost directly below that in which the *Plesianthropus* type skull was found, but at about 60 ft lower level. The fossils which I have collected at this lower level appear to be similar to those above.

We already knew a species of *Crocota* from Kromdraai very closely allied to the European *Crocota spelæa*, and from some part of Sterkfontein a jaw of *Hyæna hyæna*, and from the main Sterkfontein cave portions of a hyæna with the crowns of the teeth hopelessly broken. The hyæna discovered by Dr. Silberberg is a Pliocene type which must, I think, be placed in the genus *Lycyæna*. *Lycyæna* is a primitive genus found in the Lower and Middle Pliocene of Europe and India. While there is a possibility of the Pliocene *Hyæna* surviving into Pleistocene with the sabre-tooth cats, it now seems more likely that the Sterkfontein cave is Pliocene,



DENTITION OF *Lycyæna' silberbergi* BROOM. NAT SIZE

and if so we must put the other caves to an earlier date also.

The Kromdraai skull we may put as probably Lower Pleistocene, and the Sterkfontein as probably Upper Pliocene. The Taungs skull, which must be much older, we may assign to the Lower part of the Upper Pliocene or even to Middle Pliocene. Of course, it will be readily understood that the difficulties are great, and the evidence very little. The director of the South African Geological Survey, Dr A W Rogers, said in 1925 that "there was no probability of the age of the (Taungs) deposit being determined", and so far as I know no geologist has ever made any attempt to solve the difficulty. Still, some attempt must be made. So much hangs on it.

If the Taungs ape-man is of Pliocene, and possibly even Middle Pliocene, age it may again assert its claim to be very near to man's ancestor. Its teeth are practically identical with those of some Bushmen.

A full account of all we know of the South African ape-men has been prepared by Dr G W H Schepers and myself, and it is hoped that this work will be published this year

Transvaal Museum,
Pretoria
Jan 27

R BROOM

Index of Diversity as Applied to Ecological Problems

IN Research Items in *Nature* of December 30, p 833, attention is directed to Dr C B Williams' recent paper¹ in which he applies the 'index of diversity' (α) to populations of various kinds. He claims that α is a property of the population, and is independent of sample size. He attempts to use it for the relation between numbers of species and size of sample in samples of plant populations obtained by means of quadrats, and in using some figures of Gleason's implies that, given a random distribution of quadrats, the application of α would be valid.

It is difficult to test these assumptions directly, since it is usually impossible to count individuals of plants, and therefore impossible to obtain the relation between numbers of species and numbers of individuals. Recently, while engaged on work for the Forestry Commission, I obtained figures for the composition of various kinds of heath vegetation, using quadrats of different sizes. The figures obtained show that the index of diversity varied both with the way in which the quadrats were distributed (random or otherwise) and with the quadrat size. Thus α obtained by using quadrats of 1/8 square metre (quadrats being grouped together to give the varying sample sizes) was about 7, while α derived from counts of the mean numbers of species in quadrats of three different sizes (1/20, 1/8 and 1 square metre) was about 1.2. In the case of a piece of old *Calluna* heath in which there were only six species of flowering plant, 76 per cent of the cover being provided by *Calluna*, while *Empetrum nigrum* and *Vaccinium myrtillus* formed the remainder, the calculated number of individuals expected from Williams' formula was 3,000 per square metre. The actual number was not recorded, but the calculated number is obviously absurd.

Thus the index of diversity is apparently not applicable to numbers of plant species present in quadrats. The reason would seem to be that the formula takes no account of the amount of space occupied by the individual. In the insect populations first studied by Williams, sample size was defined by number of individuals—a fundamentally different method of sampling from that of taking quadrats, in which sample size is defined by area. The method of sampling an insect population comparable to taking a quadrat would be to take all the insects present in a given volume of space at any instant. While Williams' formula and the index of diversity derived from it may be valuable in some cases, it appears that the theoretical basis of its application needs further study.

E W JONES

Imperial Forestry Institute,
Oxford

I HAVE read with interest Mr Jones's letter on the results of the application of the logarithmic series and the index of diversity to his quadrat observations. I completely agree with him that the theoretical basis requires further study, as also does the field application to both animals and plants. The object of my publication, which gave a few cases selected over a wide field, was to stimulate the production of new data whether in support of the theory or not.

The essential difference between sampling in insects based on numbers and in plants based on area was emphasized by me both in the paper quoted and in an article in *Nature*¹. The application to botanical problems of a theory based on numbers of individuals was justified on the assumption that within one ecological formation the number of individuals could usually be considered as proportional to the area. This is only true if the size of the area sampled is large enough to contain a fair sample of the vegetation. In spite of this difficulty, I was surprised to find that in the sets of data that I collected almost at random from botanical literature, the results were consistent with the logarithmic series, and gave not unreasonable estimates of the numbers of individuals on a quadrat. If Mr Jones's figures do not so fit, then it will be interesting to find the reason.

Even in animals, however, it is not always necessary to know the exact number of individuals in order to apply many of the general principles of the log series, including the index of diversity. For example, if two random samples of insects from the same population by the same method give x individuals of 40 species and $3x$ individuals of 60 species, then it is

possible to say that $\alpha = \frac{60-40}{\log_e 3} = 18.2$, without know-

ing the value of x , except that it must not be too small. This very closely resembles the case of two quadrats of size 1 and 3 units with an unknown number x of individuals on each unit area.

In the limits of a letter, Mr Jones cannot give all the essential data, but I will take first his statement about quadrats of 1/20, 1/8 and 1 square metre giving $\alpha = 1.2$. This would suggest, on the basis of the log-series, that if there were x species on 1/8 sq m there should be approximately $x - 1.1$ on 1/20 sq m and $x + 2.5$ on 1 sq m ($x - \alpha \log_e 2.5$, and $x + \alpha \log_e 8$). On the other hand, his data for several quadrats of 1/8 sq m on the same area giving $\alpha = 7$ would imply that if there were x species on 1/8 metre, there would be about $x + 14.5$ on $8 \times 1/8$ sq metres, in other words, that eight separated quadrats of 1/8 sq metre gave 12 species more than 1 sq metre in a block. I suggest that the obvious explanation is that there was a strong aggregation of plants of each species in groups. When this is occurring, there will be very great differences between single small quadrats both in number of species and number of individuals, and one would not expect conformity with the log series unless the size of the sample was considerably increased. It is pointed out in the paper quoted that the application of the log series to quadrats is only justified if the number of individuals in the quadrat is large compared with α . In the locality studied by Mr Jones it seems likely that an area of 1/20 m, with plants as large as *Calluna*, might easily contain only one or two individuals.

Whether or not the whole conception of the log series could be extended to allow for aggregation, that is, to include a measure of it, I do not know,

¹ *J. Ecol.*, 32, 1 (1944)

but it is an interesting possibility. For the moment, I think it is better to say that with extensive aggregation the size of the sample must be increased.

I trust that I have done justice to Mr Jones's remarks, without having access to his data.

C B WILLIAMS

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¹ *Nature*, 152, 264 (1943).

Colour Vision of the Fovea Centralis

I HAVE read with great interest the letters of Drs Stiles, Thomson and Pirenne in *Nature* of February 10, in which among other things König's early work is mentioned. Some experiments to be described below indicate, I think, that the factors involved are more complicated than has previously been supposed. Mr Willmer is under the impression that it is only the fovea centralis that suffers from some form of dichromatism. I find, on the contrary, that it is a considerable area of the retina which is affected at times by this defect, all that has to be done to make the greater part of the retina appear dichromatic is sufficiently to reduce the visual angle of the test object.

When König investigated the colour vision of his fovea centralis, and found dichromatism there, he found he had to preserve very strict central fixation, since small deflexions of the eye axes caused the true colours of the test objects to be perceived. Mr Willmer¹ found a similar state of affairs. "If the eye is focused not on the centre of the circle (circular test object) directly but on the point A, about 4 cm. from the centre of the circle, then all the quadrants stand out in their true colours." Now, I do not find this, and neither does my observer, G W J. In our cases, if the test object is small enough to cause dichromatic vision on the fovea centralis, then it is also small enough to cause similar dichromatism on whatever part of the useful retina the image falls.

Clearly there is here a marked difference of observation. But there is another difference even more marked which must be alluded to. Mr Willmer used as his test object a circle 2 cm. in diameter, which was divided into quadrants. He found that the colours of these quadrants became modified when the test object was viewed with one eye from a distance of about 3 metres. I have myself used his test objects, which he very kindly placed at my disposal for the purpose, and I found that I required a much greater distance than 3 metres for dichromatism to show itself.

The test object I have been employing consists of a bright yellow square, the dye used being a saturated solution of picric acid in water. If the square had 1 cm. sides, the distance required to exhibit dichromatism, by the square becoming white, would be approximately 16 metres. It would seem from these facts that my fovea centralis is more 'resistant' to dichromatism than Mr Willmer's in the sense that the test object has to be reduced in size much more for me than it has for him.

Two of my observers, E C T and J E T, obtained substantially similar results to myself, on the other hand, two other observers, J L de S and G N J, approximate more to Mr Willmer in their experimental findings. It is clear that observers differ in detail, but in this important particular they are all alike: all find that dichromatism is

not a property of the fovea centralis alone, but is present also in the more peripheral parts of the retina. The following example brings out this point clearly.

The observer G W J found that his fovea centralis was trichromatic when the distance of the test object was 3 metres from his eye. It was dichromatic when the distance was 4 metres. The demarcation between the two types of vision occurred at about 3.6 metres. When a fixation point 4 cm. to one side of the test object was fixated, trichromatism was found at 3 metres, dichromatism at 4 metres, the transition between the two types of vision occurring at 3.3 metres. When the fixation point was 8 cm., the distance in each case is somewhat less, and the transition occurred at 2.9 metres.

It is relatively easy to explain a dichromatism which affects a limited portion of the retina such as the fovea centralis. One can suppose, as Mr Willmer has done, that an essential sensory structure such as that responsible for the blue sensation is absent from this region. It is much more difficult to explain a dichromatism which appears sometimes and not at others throughout a large area of the retina, and seems to vary according to the size and distance of the test object.

An attractive hypothesis would be when objects produce on the retina images smaller than a certain size, the blue receptors which are stimulated become so few in number that their impressions fail to get through to consciousness. I find, however, that this supposition is contrary to the observed facts. If the process taking place was one of blue blindness, then one would expect white objects to appear yellow, since this is the combined result of stimulating the remaining red and green receptors. But such is definitely not the case, for we do not find that white becomes yellow, quite the contrary, it is yellow which becomes white.

In support of the contention that the dichromatism is not caused by blue blindness, the following experiment may be quoted. The observer takes up a position in respect of a yellow test object at which it is just beginning to be confused with a white test object of the same shape and size. He now places a deep blue filter in front of his eyes and looks at the brightly lit sky for several minutes. Having reduced the sensitiveness of his blue receptors by this technique, he suddenly removes the filter from his eyes and without delay critically examines the yellow and white test objects. He finds both of them to be a brilliant yellow, in other words, he gets a result which is entirely different from that produced by a reduction of the size of the test object. Whereas inhibiting more or less completely the blue receptors causes white to become yellow, the dichromatism produced as a result of reducing the size of the test object causes yellow to appear white.

When test objects having colours other than yellow are investigated, it will be found that the following changes occur: red and orange remain unchanged, yellow, yellow-green and green have blue added to them, blue-green remains unchanged, blue, violet, mauve and crimson have blue subtracted from them.

It seems that the addition of blue to some colours and its subtraction from others points to the existence of quite a complicated mechanism which sharply differentiates the colours. This mechanism may depend on the brightness of the colours, since yellow, yellow-green and green are relatively bright colours, whereas blue, violet, mauve and crimson are relatively

dark ones. The fact that blue is added to some colours and subtracted from others accounts, I think, for the fact that white remains unaltered.

Further experiments are in progress in order to determine more exactly the nature of the colour change, and the means by which it is brought about.

I should like to thank J E T, J L de S, G N J and E C T for the trouble they have taken in acting as observers for me

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Feb 13

¹ *Nature*, 153, 774 (1944)

Nutritive Value of Coconut

IN NATURE of September 30, 1944, p 437 occurs the statement "and from these accounts it appears that babies fed entirely on coco-nut prepared in various ways until they are more than eighteen months old may be as healthy as those that are breast-fed"

The kernel of the coconut contains 35-45 per cent of oil, about 15 per cent of carbohydrates and a little less than 5 per cent of proteins of low biological value for infants. The kernel is very indigestible for adults and more so for infants when taken in large amounts, because of the great quantity of fibrous matter it contains.

The commonest preparation in the diets of those who consume much of this nut is 'coconut milk'. This is prepared by kneading grated coconut into two or three lots of water and mixing them together; the emulsion thus formed has much the appearance of cow's milk.

The analysis of coconut milk shows that the greater part of the oil has gone into emulsion with some of the protein and carbohydrates, and the residue of the grated nut contains all the cellulose and other indigestible matter of the kernel. It must be in this form, perhaps after mild fermentation, that coconut is given to infants. Supposing an ounce of grated coconut is used to prepare two ounces of milk, then the milk will contain less than 0.5 gm. of protein, about 5 gm. of fat and 1.5 gm. of carbohydrates per oz; there will be about as much sodium chloride and about half as much calcium as in human milk. Coconut is notoriously deficient in vitamins, and the milk contains a little thiamine, probably enough to deal with the metabolites from the small amount of carbohydrates in the milk, but there are only traces of carotene and ascorbic acid.

Undoubtedly biological adaptations have taken place, whereby some races are able to digest and find ample sustenance in foodstuffs which would not bring health and longevity to peoples of some other races. Probably coconut milk can supplement human milk to a small extent. It is, however, difficult to believe that the infants of any race can be weaned and thrive for a year or more on an oily diet deficient in proteins and calcium and containing only traces of vitamin A (carotene) and ascorbic acid.

Statements concerning native diets in many parts of the world are often at variance with our newer knowledge of nutrition, very little knowledge exists

of the dietary habits of the races of the world. There is an urgent need for dietary surveys to be carried out by scientific workers well acquainted with the difficulties of the subject. Such surveys will be of the greatest importance to supplement and perhaps modify some of the present views on human nutrition founded to a great extent on animal experiments. But all such surveys must be accompanied by surveys of the growth and state of nutrition of all classes among each people.

LUCIUS NICHOLLS.

THE term 'coconut milk' is usually applied to the fluid contained in the centre of the nut. It seems to have a very low nutritional value, containing only about 0.4 per cent of protein, 5 per cent of carbohydrate and a negligible vitamin and calcium content. Its calorific value is only about 20 per 100 gm.

The flesh of the fresh coconut, on the other hand, contains, according to the figures I have by me, a little more than 4 per cent of protein, which is certainly of poor biological value, about 39 per cent of fat and rather less than 9 per cent of carbohydrate, giving the relatively high calorie value of 400 per 100 gm. The calcium and iron contents are low. The only vitamin analyses I have for the flesh of the fresh fruit show a very small vitamin B₁ content of 0.03 mgm per 100 gm and about 2 mgm of ascorbic acid per 100 gm. Vitamin A, either preformed or as carotene, is almost certainly absent.

Broadly speaking, therefore, the criticisms contained in Dr Nicholls' letter can be sustained.

J C DRUMMOND

Linoleic Acid, α -Tocopherol and Other Fat-Soluble Substances as Nutritional Factors for Insects

It is now well established that, for growth, insects require a sterol in the diet. We have now established the need for other fat-soluble factors in experiments on the nutrition of a number of insects. Thus the caterpillars of *Ephestia kuehniella* grow very badly on an artificial diet consisting of casein, glucose, yeast, cholesterol, salt mixture and water. A few reach the pupal stage after a long time, but moths invariably fail to emerge. With *Ephestia elutella*, growth is relatively better on such a diet, but again, the moth fails to emerge. This deficiency is entirely overcome by adding wheat germ oil in quantities of approximately $\frac{1}{2}$ -1 per cent of the diet.

We have saponified wheat germ oil and tested the two resulting fractions (saponifiable and unsaponifiable) separately and combined. With both these fractions growth is as good, or almost as good, as with wheat germ oil. With the saponifiable fraction alone, *Ephestia kuehniella* still grows rather slowly, but those which reach the pupal stage ultimately emerge as normal moths. With *E. elutella* growth is almost as good as with wheat germ oil, and emergence is normal. In the presence of the unsaponifiable fraction alone both species grow very badly, and the few moths formed never emerge. Thus it appears that *Ephestia kuehniella* requires two factors contained in wheat germ oil, one saponifiable and the other unsaponifiable, while *E. elutella* probably requires only the saponifiable factor.

Further tests have made it beyond doubt that the saponifiable factor is linoleic acid. With linoleic acid and the unsaponifiable fraction, the moths of *E.*

clutella and *kuehniella* always emerge. If linoleic acid is added to the diets in insufficient quantities moths emerge, but are incompletely developed and the wings are partly or entirely lacking in scales. By adding graded doses of linoleic acid to the diet, all transitional stages between failure to emerge and normal moths can be produced, namely, deformed moths with naked wings, normal moths with naked wings or with wings more or less patchy. The same result has been obtained with graded doses of wheat germ oil. Imperfect moths are also formed when the diet contains oils poor in linoleic acid, such as coconut oil, allenblackia oil or lard.

The unsaponifiable factor in wheat germ oil which is required by *E. kuehniella* is almost certainly vitamin E. A diet which contains the saponifiable fraction of wheat germ oil or linoleic acid is greatly improved by the addition of pure α -tocopherol, in some cases even more than by the addition of the unsaponifiable fraction. There are, however, indications that the favourable effect of vitamin E is not specific. Lard, which is considered to be lacking in vitamin E, certainly contains something as efficient as the unsaponifiable fraction of wheat germ oil, if not more so. Finally, we have succeeded in demonstrating that ethyl- or propyl-gallates have an effect the same as, or similar to, vitamin E. This would suggest that the effect of the unsaponifiable factor is not a specific one, but that of an antioxidant which stabilizes linoleic acid.

There are, however, indications that linoleic acid plus a suitable antioxidant are not the only factors of importance concerned in this reaction. If it were merely a matter of having sufficient linoleic acid in the diet and having it efficiently stabilized, one would expect that growth-rate and degree of scaliness of the wings would go together, so that the growth-rate would always be high where the moths are normal, and always low where the wings are scaleless or patchy. This, in fact, is not the case. With the saponifiable fraction alone, growth of *E. kuehniella* is slow, but the moths are perfect, while with lard, growth is fast but the wings are imperfect. This suggests that a third factor must be involved in the reaction.

The consequences of a lack of linoleic acid, namely, failure to emerge, or emergence of moths with the scales missing to a greater or lesser extent, are different expressions of the same condition. The moth inside the pupal skin seems to develop normally until emergence, with the scales formed on the wings. When the moth emerges, the missing scales are always found on the inside of the cast exuvia. In the extreme case, the scales seem to stick firmly to the pupal case not only in the region of the wings but also elsewhere, notably the abdomen, so that emergence is impossible. This shows that a failure of the scales of the moth to separate from the pupal skin is the cause of the abnormal condition, this may be due to failure to excrete sufficient moulting fluid. It is interesting to note that the condition of incomplete wings which arises from a lack of linoleic acid is similar in appearance, if not perhaps identical, to a genetical aberration in *Ephestia kuehniella* described by Kuhn and Henke¹ under the term "Glasflügeligkeit". This perhaps suggests that the physiological action of this particular gene is concerned with the linoleic acid metabolism.

We have so far not succeeded in demonstrating the need for linoleic acid, vitamin E or other fat-soluble factors which are contained in wheat germ

oil in insects other than those belonging to the genus *Ephestia* (*E. cautella* as well as *kuehniella* and *clutella*). The very closely related species *Plodia interpunctella* certainly does not require linoleic acid, and probably none of the other factors. Other insects which we have tested, including about ten species of beetles and moths, do not seem to be in need of any fat-soluble factors in addition to sterols, and this agrees well with recent work on the dietetics of insects which has been conducted in other laboratories.

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M. BLEWETT

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Biological Field Station,
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Jan 26

¹ Kuhn, A., and Henke, K., *Abh. Ges. Wiss. Göttingen, Math. Phys. Kl., N.F.*, 15, 1 (1929)

Acaricidal Property of a New Insecticide, Hexachlorobenzene

FOLLOWING closely on the several recent demonstrations of the considerable insecticidal potency of 'DDT' (dichloro-diphenyl-trichlorethane) it is surprising to find another substance which, on preliminary trial, promises to be at least as good, and in some ways even better than, 'DDT'. Through the courtesy of Imperial Chemical Industries, Ltd., I have recently had the opportunity of carrying out a few trials with a substance temporarily designated '666' which has been recognized for some little time by I.C.I. research workers as possessing unusually active insecticidal properties. This substance, which may now openly be referred to as hexachlorobenzene, has the general formula $C_6H_4Cl_2$, and is a very remarkable compound in that the extraordinary insecticidal properties are held solely by the γ isomer. It is understood, however, that a general statement is shortly to be made by those who have been engaged in the development of this substance as an insecticide, when details on that interesting point will be published.

A few tests recently carried out at this Laboratory on the action of hexachlorobenzene on guinea pig lice showed it to be at least as effective as DDT. It was also found to be exceedingly toxic to the freshwater crustaceans, *Cyclops*, *Daphnia* and particularly to *Diaptomus*; but in whatever other direction this new substance may excel, its action on parasitic acari promises to be one of the most potent, as was indicated by comparative trials carried out on rats severely affected by notoedric mange. In these trials a comparison was drawn between the efficacy of 1 per cent solutions in liquid paraffin, or olive oil, of hexachlorobenzene, benzyl benzoate, tetraethylthiuram-monosulphide ('Tetmosol') and 'DDT'. Of these four substances hexachlorobenzene was found to be much the most active, and, apparently, without any danger to the treated animals. 'DDT', on the other hand, showed very little effect, and in a second series of trials, when used in 2 per cent strength, led to the death of some of the experimental rats after the development of marked hyperaesthesia and frequent clonic muscular spasms.

A preliminary cleansing of the affected parts of the rats with soap and water was not carried out in these tests, nor was the whole surface of the body treated with the dressings, which were applied only to the affected (hairless) parts. As complete cure

was brought about under these relatively difficult conditions, and living mites were not found in the old lesions, it is thought that in all probability hexachlorobenzene will ultimately prove to be of great value in the treatment of psoroptic scabies (including 'sheep scab') in animals, and of sarcoptic scabies in animals, and also in man

E L TAYLOR

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Weybridge. Feb 7

'D.D.T.' as a Sheep Blowfly Dip

THE powerful toxic action of 'D.D.T.' on many species of flies has made possible a new method of attack against the sheep blowfly *Lucilia sericata* (Mg) and related species. As the following experiments indicate, control may be achieved by the direct action of a 'D.D.T.' dip on the blowfly while the insect is searching the fleece for a site suitable for egg-laying.

The preliminary laboratory experiments were made by Dr E T Burt of the Unit of Insect Physiology (Agricultural Research Council), who showed that sheep wool dipped in an emulsion containing 0.5 per cent 'D.D.T.' was toxic to laboratory-bred specimens of *L. sericata*. The following field tests gave results in keeping with this observation and demonstrated that the toxic effect could take place rapidly enough to prevent gravid females of *L. sericata* from ovipositing on sheep.

Two dipping trials were made on farm flocks consisting mainly of Welsh mountain sheep. In both cases the same dipping procedure was adopted and the same 'D.D.T.' emulsion (M 21) used.

In the first trial eighty-one sheep were dipped, the concentration of the bath falling from 0.3786 to 0.3264 per cent 'D.D.T.' in the course of the dipping. The sheep remained free from strike throughout the period of the experiment, August 8–September 18, a total of forty-two days. It was not possible to have a control group grazing with the experimental flock, but chemotropic experiments made on this particular farm indicated that conditions for strike were better in August and September than in the four weeks prior to dipping, when ten strikes were recorded in the flock. Further, bad cases of maggoting were reported on neighbouring flocks.

The second trial comprised a total of 430 sheep grazing on five different regions of one farm. Each grazing unit was divided into two equal groups as regards breed, age and sex. One group was dipped with the 'D.D.T.' emulsion and the other with a commercial arsenical dip. The 'D.D.T.' concentration fell from 0.4540 per cent to 0.2388 per cent in the course of the dipping.

The experiment lasted from August 29 to October 13, a period of forty-four days. Three strikes occurred on 'D.D.T.'-dipped sheep, one of these was a re-strike. Twenty-one strikes occurred in the control group which had been dipped with the commercial preparation, no re-strikes were recorded in this group. In the control group the first strike occurred six days after dipping and in the 'D.D.T.' group twenty-four days after dipping, by which time thirteen strikes had been recorded on the controls.

The following experiments clearly show that the effectiveness of the dip lay in its direct action on the blowfly.

Three weeks after dipping, specimens of *L. sericata* were captured from undipped and 'D.D.T.'-dipped sheep. Of twenty-five flies caught on the undipped sheep, two died in twenty-four hours. Of thirteen caught on the 'D.D.T.' group, nine died in twenty-four hours. All the flies which died, including those caught on the control group, showed symptoms of 'D.D.T.' poisoning within 15–30 minutes of capture. A similar test five weeks after dipping showed one death out of sixteen flies captured on the controls and five out of sixteen captured on the 'D.D.T.' group.

Tests in which gravid females of *L. sericata* were kept in contact with the fleece of a 'D.D.T.'-dipped sheep showed that even five weeks after dipping, 30–60 seconds contact was sufficient to have a toxic effect on the flies.

The action of the dip in preventing oviposition was clearly demonstrated by tests with artificial attractants. The Hobson¹ technique was employed, and five 'D.D.T.'-dipped with five undipped sheep were used in each experiment.

NUMBER OF EGG BATCHES LAID IN REGION OF ATTRACTANT

Date 1944	No of days after dipping	Sheep dipped with 'D.D.T.'	Control group undipped
Aug 8	0	No test	
" 10	2	0 0 0 0 0	2 1 3 1 1
" 15	7	0* 0 0 0 0	0 2 2 1 0
" 23	15	0 0* 0 0 0*	4 3 8 7 3
" 30	22	0 0 0 0 0*	3 0 2 - -
Sept 7–11		Weather conditions not suitable for tests	
" 12	34	0 0 0* 0 0*	3 2 - - -
" 19	41	0 0* 0 0 0	Controls not available
" 21	43	0 0 0 0 0	3† 2† 0† 0† 0†

* From 3–6 scattered eggs laid, except in the case on September 19, when 15 eggs were found.

† The sheep used as controls on September 21 had been dipped with a proprietary arsenic dip on September 19.

The accompanying table summarizes the results obtained. On no occasion was a complete and compact batch of eggs laid on the 'D.D.T.'-dipped sheep, whereas oviposition was invariably induced on the control group. The results obtained on September 21 are of particular interest because the control group had been dipped with a proprietary arsenic dip only two days previously and their fleeces were sticky and had a strong odour, yet oviposition occurred on them but not on the sheep which had been dipped with 'D.D.T.' some six weeks previously.

In the course of the 1945 blowfly season, the dip is to be given extensive field trials and attempts are to be made to increase its effectiveness by combining an attractant with it, thus making the dipped sheep act as blowfly traps.

I wish to thank Mr L Davies for assistance with the field experiments and Dr J G Mitchell of the DSIR Chemical Laboratory for the preparation of the 'D.D.T.' emulsion and for determining the 'D.D.T.' concentrations mentioned above.

J B CRAGG

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at the School of Agriculture,
University College of North Wales,
Bangor

¹ Hobson, R. P., *Ann Appl Biol*, 24, 627 (1937)

Hydrogen Sulphide Gas as a Preventive of Putrefaction

IN a collection of old microscope slides recently re-examined, a series came to light illustrative of observations made by me some twelve years ago and not hitherto published. They are perhaps of sufficient interest to be put on record now.

During the course of work on the sterilization of dried hides from anthrax¹, the lines of which were suggested by observations by Andriewski², on the toxicity of hydrogen sulphide for anthrax spores, it was found that anthrax spores could be killed by exposure in anaerobic jars to an atmosphere of this gas.

To find out whether hydrogen sulphide was toxic in the same conditions to other micro-organisms and might therefore delay or prevent putrefactive changes, the following experiment was done. Pieces of raw hide newly removed from the animal were put in anaerobic jars—either suspended or laid in petri dishes. The air in the jars was then exhausted by means of a vacuum pump and hydrogen sulphide run in from a kip—being passed first over 1 per cent caustic soda to remove any trace of hydrochloric acid that might be present. The jars were allowed to stand at room temperature or at 37° C. Cuttings from the samples under treatment were taken at intervals, sectioned, stained and compared with cuttings from the same hide kept in air in similar jars at the same temperatures. The hydrogen sulphide jars were refilled at once with the gas after each time of opening.

It was found that in the pieces kept in an atmosphere of hydrogen sulphide, putrefaction was almost entirely checked for a period of at least a week at 37° C. and a month at (approximately) 20° C. One hydrogen sulphide jar was kept sealed (and forgotten) for eight years. At the end of that time the sample of hide was still moist and sufficiently intact to be sectioned, and though the epidermis and cellular structures in general had disappeared and there was considerable breakdown of the fibre bundles, the main outlines of the hide structure were still traceable.

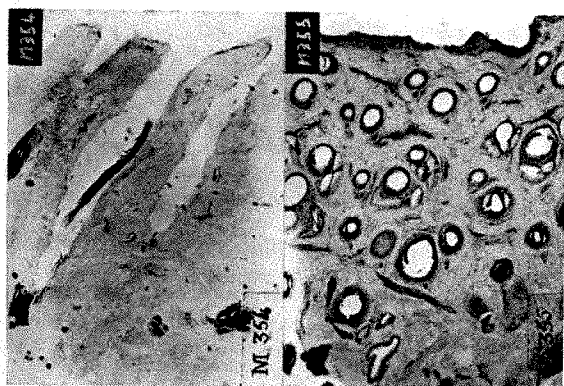


Fig. 1.

Fig. 2.

Fig. 1. OX HIDE KEPT FOR THREE DAYS IN AIR AT 37° C. IN A SEALED JAR.

The epidermis and all the other cellular structures (sebaceous and sweat glands, linings of hair follicles and interstitial cells) have disappeared. The fibre bundles are loosely woven and are showing signs of breakdown.

Fig. 2. OX HIDE KEPT FOR SEVEN DAYS AT 37° C. IN HYDROGEN SULPHIDE IN A SEALED JAR.

The epidermis and other cellular structures are intact or practically so. The fibre bundles are compactly woven and show little or no sign of degeneration.

The accompanying photomicrographs illustrate the condition of the air-treated sample after three days at 37° C. and of that treated with hydrogen sulphide after seven days at the same temperature.

Unfortunately the section shown in Fig. 1 was cut in the direction of the hair follicles and that shown in Fig. 2 across their main direction. In spite of this, however, the much better state of preservation of the sample shown in Fig. 2 is obvious.

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Feb. 13.

¹ Robertson, *J. Hyg.*, **32**, 367 (1932).

² Andriewski, *Amer. J. Bact.*, **16**, 151 (1928).

Vernalization of Rice by Short Days

IN a previous communication¹, the effectiveness of the method of vernalization of rice by short days has been reported. The method has been tried further with several varieties of rice grown in Bengal, and interesting results of agricultural importance in one winter variety, 'Rupsail', have been noted.

Flowering duration of this variety has been reduced from 133 to 47 days by this method. So far as we are aware, flowering of winter varieties of rice within such a short period has not been reported previously. By applying short days to several varieties of rice, Alam² came to the conclusion that all varieties require a minimum period of 30 days for vegetative growth and a succeeding period of about 30 days of short-day treatment for coming into flower.

This acceleration of flowering has great possibilities for the cultivation of rice in Bengal. First, a variety of fine rice could be grown in a much shorter time; secondly, by inducing early maturity, it could escape flood; and thirdly, early harvesting would leave sufficient time for the preparation of fields for the crops following in rotation.

A full report of this work will be published elsewhere. We wish to express our thanks to Prof. S. P. Agharkar for encouragement and facilities to carry out this investigation.

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B. PARIJA.

Department of Botany,
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Nov. 7.

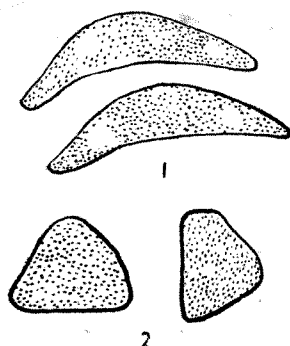
¹ *Nature*, **153**, 378 (1944).

² See Sci. Rep. Rice Res. Stat., Sabour, Bihar (India), 1940-41.

Two New Records of *Sphacelia* from Mysore

IN the course of his studies on the sugary disease of *Sorghum vulgare* caused by *Sphacelia Sorghi* McRae, Ajrekar¹ recorded three other wild grasses, namely, *Andropogon caricosus* var. *mollicomous*, *Ischaemum pilosum* and *Pennisetum alepecurus* as having the *Sphacelial* stages of an ergot. Sclerotial stages were observed by him only on the last-named host, and he pointed out that heavy infestation by a species of *Cerebella* competed with the formation of sclerotial stages in other cases.

Collections of ergot on wild grasses in Mysore I have made included *Sphacelial* and sclerotial stages



1. SPORES OF *Sphacelia* on *Brachiaria distachya*. 2. SPORES OF *Sphacelia* ON *Amphilophis pertusa*. $\times 1800$.

tion, which at first is translucent, later on hardening into a whitish crust associated with saprophytic yeast cells. Numerous oblong-ovate spores (which are slightly arcuate and slightly pointed at the tips) of the *Sphacelia* become embedded in the nectar. The spores measure $12.6-19 \times 3.8-6.3 \mu$. Subglobose to spherical sclerotia are formed only in a few cases unaffected by *Cerebella*. In the absence of germination stages of the sclerotia, the identity of the *Claviceps* species remains obscure.

The *Sphacelial* stages on *Amphilophis pertusa* are also restricted to individual florets. Partial development of sclerotia due to infestation of *Cerebella* have been observed in some cases. The conidiospores are numerous, hyaline, borne on conidiophores developed as a felt on the surface of the ovary. The spores are distinctly triangular, somewhat rounded at the ends, measuring $8.8-11.4 \times 6.3-7.7 \mu$. Such a type of triangular spores is at variance with the *Sphacelia* of *Claviceps* species recorded both on members of Gramineae and Cyperaceae. On account of the differences in size and shape of the spores, the name *Sphacelia Amphilophidis* is tentatively proposed for the accommodation of the fungus. Detailed description and diagnosis of the species are being published separately.

Grateful thanks are due to Dr. L. N. Rao, professor of botany, University of Mysore, for kind encouragement.

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¹ Ajrekar, S. L., *J. Ind. Bot. Soc.*, 5, 55 (1926).

Scattering of Light in Crystals

SINCE its discovery¹, early in 1928, the scattering of light with altered frequency has been investigated in many crystals, and much valuable information has been accumulated. The significance of the results and their relation to theories of the solid state are clearly matters of great interest.

The outstanding result of the experimental studies is that the atomic vibration spectrum of crystals in the infra-red region reveals itself in light-scattering as a set of discrete frequencies, the approach to monochromatism being the more complete the more perfect the crystal, and the lower the temperature at which it is studied. It is particularly significant

that this feature obtains not only in respect of the so-called internal vibrations of the ions or molecules comprised in the crystal, but also in respect of their translatory and rotatory oscillations which are characteristic of the crystalline state. As a typical case, calcite may be mentioned. Dr. R. S. Krishnan has recorded extremely intense spectra with this crystal employing the 2537 Å. radiations of a water-cooled, magnet-controlled quartz mercury arc as the exciter and giving prolonged exposures. Besides the internal vibrations of the CO_3^{2-} ions and their translational and rotational oscillations, octaves and combinations of these frequencies are also found recorded in the spectrum. All of them appear as sharp lines, but not a trace of continuous spectrum is noticeable on the plates.

Comparative studies with various substances in the molten and solid states make it clear that every mode of infra-red vibration which gives rise to appreciable variations of optical polarizability in the volume elements of a crystal also manifests itself as a frequency-shift. Hence, as in the cases of gases and liquids, we are entitled to infer that the spectrum of light-scattering in a crystal is a faithful map of the fundamental infra-red vibration spectrum, excepting only the modes for which the symmetry excludes any variation of optical polarizability.

Recently, by a straightforward dynamical investigation², I have shown that the fundamental vibration spectrum of a crystal containing p sets of non-equivalent atoms consists of the $(3p-3)$ modes which repeat themselves in adjacent cells of the Bravais lattice, and in addition $21p$ other modes in which the phase alternates in successive cells. The prediction confidently made that these $21p$ modes should also manifest themselves in light-scattering has been strikingly confirmed by Dr. R. S. Krishnan³ in the case of diamond.

It is clearly impossible to reconcile the facts stated above with the theories of the solid state which assume, or claim to show, that the atomic vibration spectrum of a crystal in the infra-red region is a continuous one. To effect any such reconciliation, it would be necessary to invent a mechanism which could transform the assumed continuous spectrum of frequencies into a discrete line spectrum by a process of exclusion. One such mechanism which has often been suggested is that the phases of the infra-red vibration are perfectly coherent over the whole volume of the crystal, in consequence of which all the scattered radiations disappear by optical interference except those arising from the so-called limiting modes of vibration, $(3p-3)$ in number, the phase wave-lengths of which are comparable with the length of the light waves and satisfy the Bragg condition for reflexion. To this suggestion, however, there is a fatal objection, namely, that $21p$ other modes which have much smaller phase wave-lengths not satisfying this condition are also observed in light-scattering, while the infinitely numerous others which are also assumed to exist in the aforesaid theories fail to manifest themselves. A further objection is that, in actual crystals, the assumed coherence of phase can scarcely be expected to extend over sufficiently great volumes for optical interference to be effective. For the latter reason, the continuous spectrum assumed to exist in such theories should manifest itself fully in light-scattering or at least give an observable indication of its existence. Since this is not the case, we can only infer that the postulated continuum does

not exist in the infra-red region of frequency. We are, of course, here not discussing the low-frequency or elastic solid vibrations in which the discrete atomic structure is not explicitly involved

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Feb 14

¹ Raman, C. V., *Ind J Physics* (1928)

² Raman, C. V., *Proc Ind Acad Sci*, A, 18, 237 (1943)

³ Krishnan, R. S., *Proc Ind Acad Sci*, A, 19, 216 (1944)

X-Ray Crystallography of Kojic Acid

AT a time when its identity was uncertain, specimens of the compound isolated by M. A. Jennings and T. I. Williams¹ from *Aspergillus effusus* were examined in order to determine its molecular weight. The compound was later shown to be kojic acid. It forms monoclinic needles elongated along [100] and showing the forms {100}, {010} and {021}. The following data for the unit cell were obtained from X-ray oscillation photographs: $a = 3.85$, $b = 18.4$, $c = 8.84$ Å, $\beta = 74^\circ$, correct to about ± 1 per cent.

Absent spectra indicate that the space group is $P 2_1/c$ and the density determined by flotation in an ethylene dibromide-bromobenzene mixture is 1.559 ± 0.006 . The space group allows any even number of molecules in the cell, and if four molecules are assumed the molecular weight is 142 ± 3 . This value is in good agreement with the formula $C_6H_6O_4$ (mol wt 142) and with the quantitative analysis and cryoscopic determination of F. Traetta-Mosca².

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¹ *Nature*, 155, 302 (1945).

² *Ann Chim Applicata*, 1, 477 (1914)

Long Duration of the Balmer Spectrum in Excited Hydrogen

LORD RAYLEIGH has reported recently¹ the results of a new experimental determination of the duration of the emission of hydrogen Balmer lines, H_α , H_β and H_γ . Hydrogen (pressure 0.2 mm mercury) was excited by an electrodeless discharge in a tube having the form of a square ring connected with a side tube, through which it was exhausted. Each discharge (of very short duration) produced a luminous jet squirting out of the discharge space, along the tube. The light emitted by the jet contained the Balmer lines in question. From the measurements of the speed of the jet (by means of a revolving mirror) and of the decay of luminosity at various distances along the tube, the durations of these lines were determined. In some conditions they appeared to be roughly one thousand times greater than the values calculated theoretically as well as those given by previous experiments. As Lord Rayleigh states, the difference of behaviour of the lines is not very marked, and not always noticeable.

Since, presumably, one of the purposes of Lord Rayleigh's paper was to rouse discussion, I should like to put forward a possible explanation of his unexpected

results. The mean duration of lines is not always identical with the mean life in initial states of corresponding transitions. This would be the case only if no transitions from higher levels to the initial level of the line (cascade transitions), no recombination of ions, no transfer of excitation energy from atoms or molecules in metastable states, no 'imprisonment' of radiation, etc., took place. From these possibilities the first two, namely, cascade transitions and recombinations of ions, seem to be not excluded in Lord Rayleigh's experiments. Thus the most probable cause of the prolonged duration of the H_α , H_β and H_γ lines seems to be the recombination of atomic hydrogen ions.

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¹ Rayleigh, *Proc Roy Soc*, A, 183, 26 (1944), cf also *Nature*, 155, 84 (1945)

Vibration in Telegraph Wires

Two winters ago while motoring over a route traversed daily for many years, we observed this phenomenon for the first time. Hence the conditions, giving rise to it must be rather exceptional. The vibration was so striking and unusual that we stopped the car to exclude the possibility of adventitious optical effects from that source. The time was about 9.15 a.m., the air clear and 'frosty', the sun brilliant, and the wires heavily loaded with ice. There was a barely perceptible breeze blowing across the road.

On the left side of the road were the usual telegraph wires, and on the right a group of four thicker insulated wires carrying lighting current. Both sets, although obviously under very different degrees of tension, were vibrating with considerable amplitude. The effect was general over several miles of road. Ultimately the right-hand wires changed direction and ran off sharply at right-angles to the road (that is, parallel to the wind stream). No vibration could be observed in this stretch. Later we ourselves turned right (that is, down wind) and here the standard telegraph wires also ceased to show any vibration.

In attempting an explanation several factors were reviewed. (1) The physical effect of temperature on the vibrating system, as defined by the 'sonometer' formula, can be ignored, as a drop of 40°C only affects the rate by about 0.1 per cent. (2) From the dissimilar behaviour of the wires orientated across and parallel with the wind stream, we may safely presume that this cross flow is an essential factor. (3) Genesis from some random specific 'air velocity vibration resonance' correlation may be excluded, as two entirely dissimilar sets of wires were simultaneously in vibration.

In view of the above, we reached the conclusion of Gilbert *et al*¹ that the vibration is initiated and maintained by the differential pressure effects resulting from an air flow across a wire of non-circular section, that this abnormal source of energy explains the abnormally high amplitude, that the visual effect is aided and intensified by the greatly increased thickness of the wires, and by the loading of the wires reducing the vibration rate below the threshold at which the persistence of vision obscures observation².

What surprised us at the time was that, despite the obvious relationship to a cross wind, the prevailing breeze was almost imperceptible

D BARRON CRICKSHANK
B FALKNER LEWIS

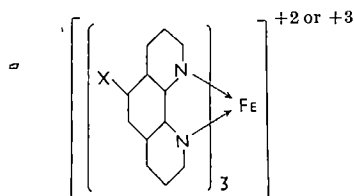
Papworth Hall,
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Nature, 155, 243 (1945)

² cf Bauchmetz and Whitehouse, *Nature*, 155, 243 (1945), "frequency approximately 10 a second"

Effect of Substituents on the Oxidation Potential of Ferrous *ortho*-Phenanthroline Complexes

IN a recent communication¹, Smith and Richter have measured the oxidation-reduction potentials of a series of substituted *ortho*-phenanthroline iron complexes

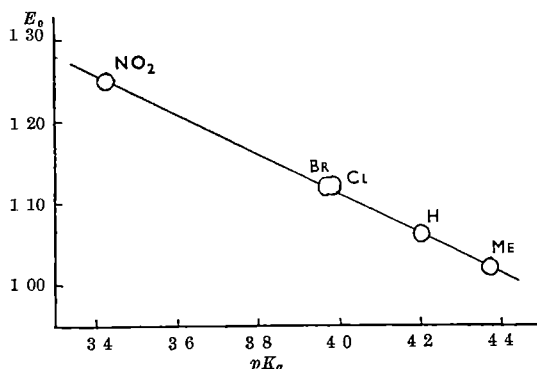


The values obtained show a marked trend with the dipole moments of the corresponding substituted benzenes. More striking, however, is the fact that a linear graph is obtained when these formal oxidation-reduction potentials are plotted against the (negative) logarithms of the dissociation constants² of the corresponding *para*-substituted benzoic acids

E_0 and $\log K_a$ are, of course, proportional to the free energy changes of the corresponding reactions. Clearly, an electron shift, for example one towards the substituent group, which in the acid series raises

X	E_0 (volts)	pK_a
NO_2	1.25	3.42 ₅
Br	1.12	3.97 ₁
Cl	1.12	3.97 ₇
H	1.06	4.20 ₃
CH_3	1.02	4.37 ₃

The equation to the line is $E_0 = 2.082 - 0.243(pK_a)$



the acid strength by increasing the repulsion on the proton, is similarly transmitted in the complex ion. The withdrawal of electrons is communicated through the co-ordinated nitrogen atoms to the central iron atom, to produce an increased binding of its electrons and a proportionate rise in the oxidation potential

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¹ Smith and Richter, *Ind Eng Chem (Anal Ed)*, 16, 580 (1944)

² Dippy *et al.*, *J Chem Soc*, 1888 (1934), 343 (1935), 644 (1936)

Causality or Indeterminism?

I HOPE it will not cause *Nature* to lose caste for a very ordinary man to join in the discussion on causality v indeterminism so ably dealt with by Prof H. T. H. Piaggio, and to express thoughts that will at least be understood by all who try to read the exceedingly specialized correspondence columns

I follow the line of argument that coin tossing is not really haphazard but governed by strict laws of causality, although the variation in launching and wind may be impossible scientifically to calculate. Incidentally, the alternative of red and black on a roulette board is the incalculable ideal, in that the ball launched round the board in the opposite direction to the spinning centre has to strike odd-shaped obstacles before rolling into the middle. Results have, I understand, for some obscure reason been chronicled for years.

When we come to atomic physics we get into heavy weather and we are not really helped by von Neumann's six laws, especially the one referring to the 'squared operator' which may convey that there is something wrong with the 'tote', but is otherwise entirely incomprehensible to the layman. Anyhow, at present the pundits plump for indeterminism.

How can this refreshing individuality in atomic physics, so stimulating in our dragooned world, react on 'homo sapiens' (sic)?

In Schrodinger's attractive book "What is Life?" with Darlington prompting him 'off', as they say on the stage, he tells us that we mortals are made a certain size in order that statistical results should obtain. A serious corollary, however, emerges in that genes are so small as to be subject to random changes as, for example, in the energy-level of their few constituent atoms. These changes are enough to account for mutants. Through no fault of our own, therefore, we may become the parents of monsters. May we now go further and be told by those who analyse the micromechanism that animates the brain whether there are there, constituent parts of such small size as also to be influenced by random atomic changes. If such be so, then the truly awful thought faces us, that all our wise decisions, all our noble or possibly questionable actions in life, are determined, not by our own high-charactered and noble 'ego', but by a microscopic atomic material part of our brain, over which we have no control, being bumped around on the quantum level.

These are grave thoughts, but if the latter hypothesis be true, although not exactly comforting, it would at least explain and indeed excuse many mistakes made in life by your obedient servant,

BRABAZON OF TARA

RESEARCH ITEMS

Origin of South American and African Freshwater Fishes

WILLIAM A GOSLINE (*An Acad Brasil. Ciencas*, 16, No 3, 1944) criticizes some of the arguments advanced by biologists who have marshalled geological evidence to agree with their own interpretation of the biological data. While the author does not attempt to offer final conclusions concerning the African and South American freshwater fishes, he summarizes the evidence supplied by the best-known freshwater group, and suggests lines of further investigation. These are included under four heads (1) The compilation of up-to-date revisions of the groups of fish involved, together with the presentation of phylogenies of these groups based on palaeontological, anatomical and physiological data. These would show the relationship of the fishes between areas as compared with those within areas (2) The demonstration from various sources of evidence that certain groups have originated and evolved in fresh water, and that salt water has always formed a complete barrier to their dispersal (3) The determination, so far as is possible, of the geographical distribution—past and present—of these groups, together with their ecological limitations (4) The correlation of all material from the above lines of investigation, special account being taken of the environmental needs affecting fish dispersal, with the derived data for other animal and plant groups and with geological and climatic history

Growth Hormones in Tetraploids

F. G GUSTAFSON (*J Hered*, 35, 269, 1944) has shown that tetraploid marigolds have 58 per cent and 76 per cent as much growth hormone as their related diploid, while the autotetraploid *Lycopersicon pimpinellifolium* has 56.8 per cent of that of the diploid. This reduction in amount of growth hormone may be related to the well-known time differences in growth between diploid and tetraploid plants

Mitosis and Cell Differentiation in the Blood

L F LA COUR (*Proc Roy Soc Edin*, 62, 73, 1944) has used new technical methods to investigate the chromosome behaviour and nuclear cycle in the origin of blood cells in man, mice, rats, cats and dogs. There is a unique difference between the precursors of myelocytes and erythrocytes in respect of the nucleic acid content of the nucleus. The pre-erythrocyte cells stain an intense red by the Pappenheim stain, whereas the pre-myelocytes stain pink. Similarly the chromosomes of the first type show a greater desoxyribose nucleic acid charge. In man with pernicious anaemia, the differences are accentuated. This leads on one hand to over-spiralization and abnormal division in the overcharged erythrocytes, and long thin chromosomes, incompletely spiraled in the myelocytes. As a result of the abnormal divisions with multiple spindles and chromosome bridges, the daughter cells often contain irregular chromosome numbers. Hypoploid cells have been found in the normal field mouse. Nucleoli are present in all precursor cells in the marrow and are later replaced by heterochromatin. Their presence is correlated with cell proliferation. The matured myelocytes in the mouse and the rat are tetraploid as a result of an abortive anaphase of the last division. White tetraploid cells occur in association with a

shortage and red tetraploid cells with an excess of both nucleic acids in pernicious anaemia. Evidence is given which suggests that the enucleate condition of mature erythrocytes is due to the extrusion of nucleic acid and not of the nucleus

Pre-harvest Drop of Apple Fruit

PRE-HARVEST drop of apple fruits which have reached or almost reached picking maturity is a serious problem confronting apple growers in America and, to a lesser extent, in Great Britain. Innumerable trials carried out in recent years have indicated that some control of this trouble may be effected by spraying the trees, shortly before picking maturity is reached, with growth-substance solutions. The standard spray used contains ten parts of growth substance per million of spray, but L Southwick reports (*Proc Amer Soc. Hort Sci*, 42, 199, 1943) that stronger sprays may be more effective and that, while dusts which can be applied more easily are as effective as solutions with some varieties, they are less effective with others. Southwick, like M B Hoffman, A V Doren and L J Edgerton, finds dusts as effective as sprays with McIntosh apples. The addition of spreaders to the sprays is not necessary, but the sprays are ineffective if their application is followed by a spraying with water (or presumably rain) within two hours (E L Overholser, F L Overley and D L Allmendinger, pp 211-219). Sprays given near midday are most effective, and the period of effectiveness may be as much as twenty-eight days, but is less if temperatures are high. The hormone sprays are without any direct effect on the firmness of the fruit or development of decay, breakdown and scald in store (M H Haller, pp 207-210), but by delaying picking they may improve colour and taste and increase the size of the fruit as harvested by permitting the attainment of greater maturity (E P Christopher and S A Pieninzek, *ibid*, 43, 29, 1943)

Mercury for Grain-Pest Control

THE method of grain-pest control as practised by the rayats in certain parts of India involves the use of mercury. It concerns the protection of stored pulses against the bean beetle, and for this purpose a drop of mercury is placed in an excavated soap nut and lodged in the storage container. D W Wright, of the School of Agriculture, Cambridge, has made an attempt to assess the efficacy of mercury for the control of several of the commoner grain pests (*Bull Entom Research*, 35, 143, 1944). Experiments showed that the vapour of mercury was fully effective in preventing reproduction of the grain weevil (*Calandra granaria*), the saw-toothed grain beetle (*Oryzaephilus surinamensis*), the lesser grain borer (*Rhyzopertha dominica*), and the Angoumois grain moth (*Sitotroga cerealella*). Zinc and tin amalgams and calomel were less effective than metallic mercury. The efficacy of a given weight of mercury is increased by subdivision, a process which increases its total surface area. The substances used were found to emit a vapour which contained free mercury. Storage of insects in mercury vapour was found to have no effect on the viability of grain weevils, neither did it influence their subsequent reproductive capacity. The action of the mercury was on the eggs, which failed to hatch. Germination and spectroscopic tests on grain that had been stored for several months with mercury gave no indication

that any contamination had occurred. The grain weevil was able to breed vigorously in grain so treated.

Crocidolite Asbestos in Western Australia

BLUE amphibole (riebeckite) asbestos occurs in seams interbedded with banded ironstones of Nullagine age in the Hamersley Ranges of Western Australia. The petrology of the deposits and the associated rocks has been described by K. R. Miles (Geol. Sur. W. Aust. Bull. 100, 1942), and there is also a report on the economic importance of the occurrences by J. S. Foxall. The banded ironstones include sideritic cherts, magnetite- and hematite-bearing cherts and banded jaspers associated, as usual, with quartzites. The ironstones are interpreted as chemical sediments in which the bulk of the iron was originally precipitated as ferrous carbonate. Under conditions of low-grade metamorphism, riebeckite has developed in these beds as (a) scattered needles, (b) massed aggregates of needles (potential crocidolite), and (c) seams of uniformly parallel cross fibres (crocidolite proper). In their geological setting, structure, composition and optical properties the riebeckite and asbestos occurrences are closely similar to those of the better-known South African deposits. The chief problem in both areas is the source of the soda required for crocidolization. Riebeckite contains six per cent or more, whereas only traces of soda appear to be present in the adjacent formations. The current hypothesis that crocidolite occupies the place of pre-existing soda-rich layers in siliceous ironstones is therefore far from satisfactory. Another possibility is that soda may have been introduced (as in albite-schists) by emanations from plutonic sources, but the absence of igneous rocks and of regional metamorphism would seem to be inconsistent with this alternative. Both in Australia and South Africa the origin of crocidolite remains a geochemical enigma.

Viscosity of Compressed Gases

THE viscosity η of a non-ideal gas was considered in 1922 by Enskog, whose formula was checked for carbon dioxide and (by Michels and Gibson) nitrogen. $\eta = \eta_0 (1 + 0.175b\rho + 0.86b^2\rho^2)$, where η_0 is the ideal gas viscosity, ρ is density, and b is van der Waals' constant. O. Leipunsky (*Acta Physicochim. URSS*, 18, 172, 1943) has shown that the formula gives quite satisfactory results for a number of gases, with a tendency at high densities to show rather higher values than the experimental, due to the change of b with pressure. The formula is thus of service in technical calculations where compressed gases are concerned. With a suitable value of b the formula also applies to mixtures, where the mathematical theory is extraordinarily clumsy and incomplete.

Absorption Spectra of Substituted Benzene Sulphonamides

ALTHOUGH several publications have dealt with the ultra-violet absorption spectra of sulphanilamide derivatives, little has been done towards identification and characterization of the individual absorption bands. J. M. Vandenberg and L. Doub (*J. Amer. Chem. Soc.*, 66, 1633, 1944) have made a study of simple sulphanilamide derivatives and find that they have one single band of strong absorption (ϵ , about 17×10^3) in the accessible ultra-violet region, about 260 m μ in neutral solution, which shifts to shorter

wave-length when the solution is made alkaline, and decreases in intensity with acidity. Simple substitution which does not change the basic ionization properties of the molecule has little effect on the wave-length of the band. With more complicated substitution, other bands appear. Sulphathiazole has a band at 257–259 m μ with the properties of the sulphanilamide band, and a band at 280–283 m μ which shifts to shorter wave-length in alkali and is not destroyed in 2N hydrochloric acid, and is probably due to the thiazole portion of the molecule. With sulphapyridine three bands are found, at 242, 261 and 311 m μ , the third being due to the pyridine portion. In alkaline solution the maximum at 311 m μ shifts to shorter wave-length and the peaks at 242 and 261 m μ apparently fuse to a single broad band of increased intensity at 245 m μ . With sulphadiazine a 257 m μ band is due to the *p*-aminobenzene sulphonamide absorption and a 241 m μ band to the pyrimidine ring. Such comparisons with simpler analogous compounds make it possible to associate the bands with absorbing groups in the molecules.

Pulsation Theory of Cepheid Variables

P. L. Bhatnagar and D. S. Kothari, Department of Physics, University of Delhi, in a paper "A Note on the Pulsation Theory of Cepheid Variables" (*Mon. Not. Roy. Astro. Soc.*, 104, 292, 1945), deal with certain points raised in Prof. Svein Rosseland's George Darwin Lecture (see *Nature*, 153, 261; 1943). Rosseland developed his theory of 'anharmonic pulsations' and found that the semi-amplitude of oscillation would have to be a quarter of the star's radius—a value which is four or five times too great for most of the Cepheids. The authors of the present paper point out that this and other results obtained by Rosseland are not inherent in the model, but arise because of an approximation introduced in the investigation. They treat the matter in a simpler way than Rosseland, assuming γ , the ratio of the specific heats, to be 5/3, and avoiding the approximation introduced by Rosseland. The conclusion is that the theory of anharmonic oscillations for the above ratio cannot account for the observed skewness in the velocity-time curve of the Cepheid variables. The observed skewness demands a semi-amplitude almost equal to R , whereas the observed value is about 0.1 R , unless the value of γ is assumed to be much greater than 5/3. A rough calculation shows that if the observed skewness is to arise for a semi-amplitude of 0.1 R , γ is comparable to 10.

Van Biesbroeck's Star

It is announced (*Harv. Obs. Card.* 697) that W. J. Luyten and P. D. Jose have found the colour index of Van Biesbroeck's faint companion to BD +4°4048 to be 1.4 and the photographic magnitude 19.5, giving a photovisual magnitude of 18.1. The colour index was derived from blue and yellow plates taken with the 36-in. reflector of the Stewart Observatory. It is surprisingly low for so faint a star (absolute magnitude 19.3 photovisually) and in addition there are several stars in the vicinity which are as red as, or even redder than, the proper motion star. This suggests the possibility that this star, which has the lowest known luminosity, is a degenerate star and approaches a black dwarf. It is remarked that it might be a star the surface temperature of which corresponds to that of an early *M* dwarf, but the luminosity of which is several thousand times lower.

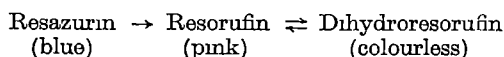
OXIDATION-REDUCTION ASPECTS OF RESAZURIN

By the late R. S. TWIGG

London School of Hygiene and Tropical Medicine
and

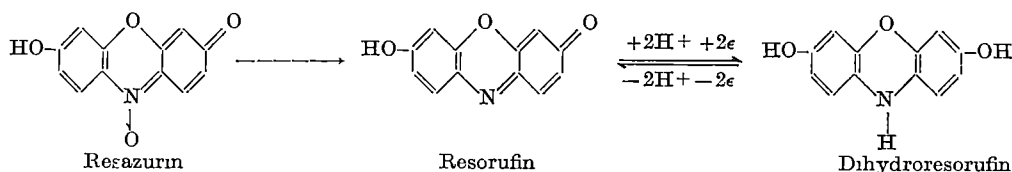
National Institute for Research in Dairying

RESAZURIN was discovered by Weselsky¹, and first used by Pesch and Simmert in 1929² for estimating the bacterial content of milk. It has lately been extensively used in Great Britain as a basis for a number of tests for the hygienic quality of milk^{3,4}. Reduction takes place in two stages



In fresh milk, reduction is chiefly due to cells (mastitis, etc.), and in aged (for example, 24 hours old) milk, to bacteria.

Work has been carried out electrometrically at 30° C in the absence of oxygen, on the two stages of reduction



Only the second stage of the second reduction is reversible at an inert electrode.

Electrometric titration curves of resazurin at pH 6.55 compared with curves of the same amount of resorufin at the same pH show that during the first reduction some of the latter is simultaneously reduced to dihydroresorufin (Fig. 1). This is true, at least, between pH values of 6 and 7.

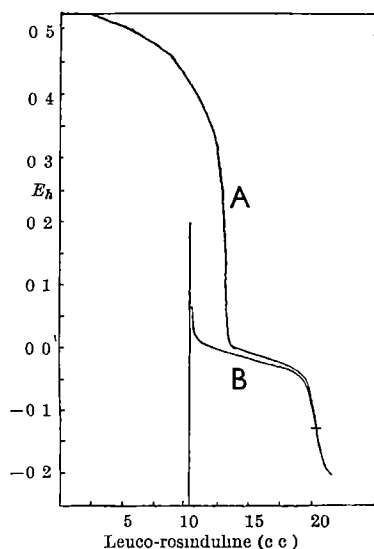


Fig. 1 A, TITRATION OF 20.00 RESAZURIN
B, " " " " RESORUFIN
All solutions 0.000132 M, pH 6.55.

The courses of the oxidation-reduction curves of the reaction $\text{resorufin} \rightleftharpoons \text{dihydroresorufin}$ resemble those of nearly all other reversible dyestuffs in that two electrons per molecule are transferred in the reaction, at any rate at pH values greater than 3.0.

The E'_0 -pH curve, constructed from the table on p. 402, is shown in Fig. 2. All points were taken from measurements made by the 'method of mixtures', but some, including those at pH 6.583, 6.867 and 7.431, have been confirmed by titration.

The curve shows four sections having $-dE_h/dpH$ values of 0.03, 0.06, 0.09 and 0.06 successively from high to low values of pH. This, together with the other chemical aspects, shows that the system conforms to W. M. Clark's formulation $\text{Ox} + 2e = \text{Red}$.

The electrode equation which describes the above findings and agrees with the observed values in the table is

$$E_h = E_0 - 0.03006 \log \frac{[SR]}{[SO]} + 0.03006 \log \left[\frac{K_1 K_2 (H^+) + K_1 (H^+)^2 + (H^+)}{K_0 + (H^+)} \right]$$

The calculated value of pK_0 is 6.93, and of E_0 is +0.380 v. By adopting for pK_1 and pK_2 the values

9.26 and 10.02 respectively, the calculated values are given in the table.

The calculated and observed values agree fairly well, except at pH values of 6.583, 6.867 and 7.431 (of which the first two fall within the normal range of the pH of milk). These three large deviations may be due to low solubility characteristics, but it was deemed unwise to decrease further the concentration of the dye (which is 0.000015 M in the experiments), owing to the ease of re-oxidation of dihydroresorufin by traces of oxygen.

From pH 3 up to the high acidities of hydrochloric

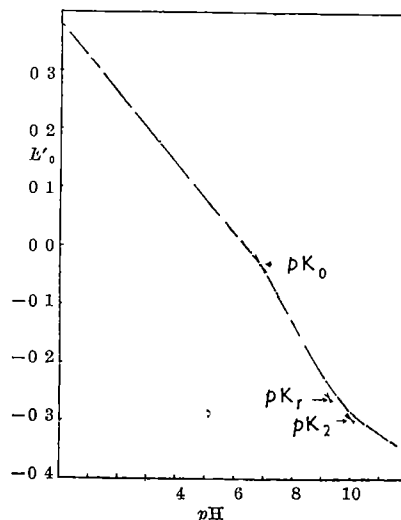


Fig. 2 RELATION OF E'_0 TO pH

pH	Calculated	Observed	Deviation
0.188	+0.369 v	+0.369 v	0.000
1.005	0.320	0.322	-0.002
1.390	0.297	0.299	-0.002
2.454	0.232	0.231	+0.001
3.392	0.176	0.176	0.000
4.477	0.111	0.111	0.000
5.570	0.045	0.045	0.000
6.119	+0.010	+0.012	+0.002
6.583	-0.021	-0.016	+0.005
6.867	0.042	0.032	-0.010
7.431	0.085	0.081	-0.004
7.880	0.123	0.122	-0.001
8.338	0.163	0.163	0.000
9.186	0.231	0.231	0.000
9.547	0.256	0.256	0.000
10.053	0.284	0.285	+0.001
10.095	0.307	0.308	+0.001
11.454	0.335	0.336	+0.001
11.743	0.344	0.345	+0.001
12.228	-0.359	-0.360	+0.001

acid or sulphuric acid, a blue-green compound, presumably a merquinone, is formed by the reduction of resorufin with titanous salts, or by oxidation of dihydroresorufin with quinone or potassium dichromate. While the reduction method shows that a merquinone having an oxidant:reductant ratio of 1:1 occurs, the oxidation method, curiously, shows a 3:2 ratio.

If a solution of resazurin be acidified to 4.76 *N* with hydrochloric acid, and potassium iodide be added to a final concentration of 0.06 *N*, a spontaneous reduction of the resazurin proceeds not only to resorufin, but also to a further half reduction of the resorufin so formed to the merquinone stage, with the release of the equivalent amount of iodine, which may be extracted with carbon tetrachloride and determined by an iodate titration. On the other hand, if the resazurin be acidified to 3 *N* with sulphuric acid or about 1.2 *N* with hydrochloric acid, and potassium iodide added to 0.06 *N*, only the complete reduction of resazurin, without further reduction of the resorufin so formed, occurs. This difference depends upon the low solubility of resorufin in the medium, and upon the observation that at these high acidities the potential of an iodine-potassium iodide mixture at a inert electrode decreases with increasing acidity which is contrary to experience with other systems.

Commercial resazurin contains variable amounts of resorufin. These latter findings have led to the development of a method for estimating the amount of resazurin in a sample together with any resorufin present as an 'impurity'.

If *A* is the iodine equivalent of the first procedure, and *B* that of the second, then, if *RZ* = resazurin, *RF* = resorufin

$$A = 2RZ + [RZ \text{ (as 'formed' RF)} + RF \text{ (as 'impurity')}] \\ = 3RZ + RF$$

$$B = 2RZ, \text{ or } RZ = \frac{B}{2}$$

$$A = \frac{3B + 2RF}{2}$$

$$\text{and } RF = \frac{2A - 3B}{2}$$

These equations have been verified by electrometric investigations carried out in conjunction with iodine estimations.

I am indebted to the Agricultural Research Council for a grant in aid of this work.

¹ Weselsky, *Berichte*, **4**, 32, 613 (1871)

² Pesch, K. L., and Simmert, U., *Milchforsch.*, **8**, 551 (1929)

³ Baker, W., *et al.*, *Biochem. J.*, **38**, 1/2, 1 (1942)

⁴ Davis, J. G., *Food Manufacture*, **17**, 308, 344 (1942)

⁵ Clark, W. M., *U.S. Pub. Health Rep.* (Reprint No. 826)

INDUSTRY AND UNIVERSITY EDUCATION

THE proceedings of the Conference of Industrial Representatives on "Industry and University Education", convened by the Vacation Work Committee of the Imperial College of Science and Technology Union on December 15, have now been published. At the first session, on "Post-war Technical Requirements in Industry", Dr P. Dunsheath, in a paper on "Industry's Requirements in Personality", suggested that university education tends to lay too much emphasis on the working of things and to give insufficient attention to human relationships and the working of the mind. University graduates are of much greater value to industry when, in addition to their equipment of mathematical and scientific data, they possess some knowledge of humanity with its intricate and sometimes contradictory relations. Urging that the universities should concern themselves with developing the characteristics making for leadership, Dr Dunsheath emphasized the importance of a sense of proportion and the ability to get ideas understood by others. He believes that more attention should be given to the classification of students according to their real aptitude for research, for design, for production or for teaching. Good brains are required in design and production as well as in research, and above all in teaching. All administrative posts in scientific industry should be filled, he thinks, by those with scientific and technical knowledge of the industry.

Mr E. R. Davies, director of research, Messrs. Kodak Ltd., pointing out that the problems of the industrial research worker always tend to lead him back to problems in pure or applied science which are not peculiar to his industry but of much wider interest, deprecated further specialization during the undergraduate years. More emphasis should be placed on postgraduate work, but the men required should be scientists first and technologists second. He thinks that technologists in the production and distribution sides would be drawn largely from the technical colleges. Although he would welcome the establishment of a university chair in photography, he would prefer to see postgraduate training continued in pure and applied science as it is at present. Its main aim should be to train a man in research methods, but he would like to see some broadening of the basis of scientific training at the graduate stage. There should be the closest possible contact between the universities and industry.

In the discussion, Lord Eustace Percy suggested that industry should find more men within its own ranks who are worthy of a university education and could profit by it. Dr G. M. Dyson referred to the need for thoroughly re-organizing the technical colleges, adequately endowing and equipping them and providing them with sufficient men to cope with teaching and to prosecute research as well. Dr J. A. C. Williams put in a plea for including the philosophy and psychology of engineering in the university engineering course, and for increased use of the technical colleges for refresher purposes.

The second session of the Conference, which considered "Post-war Requirements in Scientific Education", was opened by Prof. L. Bairstow, who pointed out that scientific education cannot be considered adequately as a separate subject apart from the rest of life, and referred to the economic difficulties

attending any extension of a student's career, especially for the majority whose work is less absorbing than research and where compensations are necessary. Specialization, or differentiation, should not come before the third year, and even then should not involve a student being committed to one field for the rest of his life. He believes that we need more training in administration for a limited number of people, who would in due course take their place with those who have studied life from a different aspect. Then we should retain, and possibly extend, a completely free atmosphere for those students who take naturally to research. We also need a better administrative attitude to research, and also technical high-schools and extended facilities in the ordinary technical schools.

Prof H V A Bruscoe confined himself to the question of producing men destined for teaching positions in pure and applied science and in the industries using applied science. He stressed the importance in recruitment of selection and of widening the field of choice, we must look critically and constructively at this question of extended recruitment and make a scientific career attract more of the really good men who at present go into other fields. Then he stressed the importance of excellence in the teaching staff with reference to imparting selected principles and facts in science so as to inculcate and develop intellectual integrity and to display the cultural aspects of science, as well as to the provision of opportunities for special development. Curricula are overloaded, and we must remember that the task is education, not teaching. Lastly, there is the question of assessment and guidance in the valuation of the graduate, so that he does what is best in his own interest and in the interests of the community. Here full co-operation of the employer is essential. With regard to the desirability of having first-class men for production, he believes that the choice between research and production should be left open and that we should aim at turning out keen, properly equipped scientific workers, whose careers would be determined by their aptitudes and opportunities.

Dr R V Southwell, stressing the importance of a real partnership with industry, suggested that we may find that the best arrangement is not one in which three years at a university are followed by two years in industry, but one in which the last of the five years sees a man returning to his university. A man who enters industry should not have finished with his university, and we might well keep a more open mind on the order in which the years are spent between industry and the university.

Mr J W Sawtell emphasized the importance of good management, he thinks that we should impress on the universities the need for men with a scientific education who can manage and handle other people, and appreciate the importance and dignity of management as a profession. Mr L P Combes pointed out that regard must be had to the question of national service and its incidence on the age of recruitment. Mr D A Bell thinks that one reason why graduates tend to enter industry only in research departments is that management has not been regarded as a worthy or scientific profession. In written subsequent contributions, Mr W S Flight referred to the economic difficulties of a long period of training and a possible solution through the State bursary scheme, and Mr M I Freeman urged that some training in the principles of industrial administration and

organization should be given by the university rather than by industry.

Dr A J F Welch referred to the importance of vacation work and of having on academic staffs those with first-hand acquaintance with industrial conditions, while Dr F M Potter, urging the value of a sound fundamental knowledge and elementary background of several subsidiary sciences, suggested that students would do well to avoid the tendency to live with men in the same year who are studying the same branch of science.

MODE OF ACTION OF PENICILLIN

IN an article on penicillin treatment in *Nature* (677, Nov 25, 1944) reference was made to the work of Lieut-Colonel J W Bigger (*Lancet*, 497, Oct 14, 1944), who concluded that penicillin actually kills *Staphylococcus pyogenes*. He suggested that it kills them at the time of division and has no effect upon individual cocci which are not dividing. These, therefore, persist in broth cultures, which penicillin frequently fails to sterilize, and are the explanation of that failure. Bigger proposed to give penicillin intermittently, in the hope that these 'persisters' would begin dividing in the intervals of the penicillin doses and so would be killed by the next dose. Bigger refers to the work of C D Gardner (*Nature*, 146, 837, 1940), who found that, in weak concentrations of penicillin, cocci swelled to three times their normal size without division, and bacilli showed similar changes.

E W Todd (*Lancet*, 74, Jan 20, 1945) also refers to this and other work in his report on his experiments on the bacteriolytic action of penicillin. Working with *Pneumococcus* Types I, II and III and with *Streptococcus viridans*, hæmolytic streptococci, staphylococci and *Clostridium welchii*, he found that all the strains of these organisms which he used were lysed by penicillin, but that such organisms as *Bact. coli* and *Pseudomonas pyocyanea*, which resist penicillin, were not lysed by it. But penicillin, he concluded, can kill organisms without lysis. When lysis occurs, its rate depends on the actual or potential rate of multiplication of the organisms. Their multiplication, as G L Hobby, K Meyer and E Chaffee (*Proc Soc Expt Biol*, N Y, 50, 281, 1942) also found, is essential for the action of penicillin. "It would appear that bacteriostasis, bactericidal action and bacteriolysis may be different stages of a single process proceeding in that order." The most rapid lysis occurs with organisms at the maximal rate of multiplication. This may be the real reason why penicillin is so effective, that is, because young actively multiplying cultures are more susceptible to bacteriolysis, so that organisms in the phase which enables them most readily to invade the human body are also then most susceptible to lysis.

These conclusions may be compared with those of Prof L P Garrod (*Brit Med J*, 108, Jan 27, 1945), who agrees that penicillin actually kills susceptible bacteria. He quotes the further opinion of L A Rautz and W M M Kirby (*J Immunol*, 48, 335, 1944) that penicillin is actually bactericidal. Garrod gives, however, only qualified support to Bigger's hypothesis that penicillin is bactericidal only to organisms when they are about to divide, which was, he says, also put forward by G L Hobby and M H Dawson (*Proc Soc Expt Biol*, N Y, 56, 178, 1944) and by C P Miller and A Z Foster (*ibid*, 56, 205).

Against this hypothesis, Garrod maintains, are (1) his experiments on the effects of temperature, like other disinfectants, penicillin is more active at higher temperatures, but is even more active at 42° C, when bacterial growth ceases, than at 37° C, incidentally, Garrod finds that its action is impaired by increase of the acidity between pH 7.0 and 5.0, (2) the fact that bacteria from both old and very young cultures are almost uniformly susceptible. Garrod therefore thinks that there is no conclusive evidence in support of Bigger's proposal to give penicillin intermittently, and claims that clinical experience supports his view. Penicillin treatment fails because the organisms are inaccessible inside necrotic areas or in undetected abscesses.

Further important conclusions drawn by Garrod are that nothing is to be gained by using higher concentrations of penicillin (cf Sir A. Fleming, *Lancet*, 621, Nov 11, 1944, see also *Nature*, 155, 341, March 17, 1945), especially in local treatment. The idea that higher doses will be more effective does not apply to penicillin. The reverse is truer. A concentration of 1 unit per c.c. is not only just as effective as one of 1,000 units, but is often more effective. The only good reason for using stronger solutions in local treatment is to ensure that the concentration does not fall below the minimum fully effective level of about 0.1 unit per c.c. Garrod further emphasizes the importance of the purity of the penicillin which is being used experimentally. He found that all commercial penicillins tested were less active in higher than in low concentrations. Presumably impurities were responsible for this, and they cause serious obstacles to the study of the action of penicillin. It will be necessary to find out whether penicillin is a single substance of unvarying composition and uniform action.

Discussing these results in a valuable leading article, the *British Medical Journal* (123, Jan 27, 1945) directs attention to the enormous variation in the susceptibility of various bacteria to penicillin. Some species classed as totally resistant are affected by higher concentrations of penicillin, for example, the typhoid bacillus and the salmonellas. H. F. Helmholz and C. Sung (*Amer. J. Dis. Children*, 68, 236, 1944) have found that some resistant bacteria in the urine are affected by high concentrations, for example, *Proteus* and some strains of *B. coli*. Only *Bact. aerogenes* and *Pseudomonas pyocyanea* remained unaffected. The treatment of some infections of the urinary tract with penicillin might thus be effective. E. W. Todd, G. S. Turner and L. G. W. Drew (*Brit. Med. J.*, 111, Jan 27, 1945) have found that *Staphylococcus* strain Oxford H can be trained by growth in increasing quantities of penicillin to become 3,000 times more resistant to penicillin than it originally was. Similar results were obtained with another strain of *Staphylococcus*. Unlike other organisms which become 'drug-fast', however, *Staphylococcus* lost this property rapidly in media not containing penicillin. The authors refer to work which showed, on the other hand, that pneumococcus type III, made resistant to penicillin, either by culture in media containing penicillin (G. Rake *et al.*, *J. Immunol.*, 48, 271, 1944) or by passage through mice treated with penicillin (L. H. Schmidt and C. L. Sesler, *Proc. Soc. Expt. Biol.*, N.Y., 52, 353, 1943), retained its resistance. The nature of these phenomena of resistance requires further investigation. Although some organisms can produce a penicillinase which destroys penicillin (see, for example, the penicillinase produced

by *B. subtilis* reported by E. S. Duthie, *Brit. J. Expt. Path.*, 25, 96, 1944), resistance to penicillin apparently does not always depend on the production by the resistant organism of penicillinase. W. M. Kirby (*Science*, 452, June 2, 1944) has extracted a substance which is not penicillinase from *Staphylococcus* resistant to penicillin. G. LAPAGE

INDIAN FOREST YIELD TABLES

EVER since the Forest Research Institute came into being at Dehra Dun (1907), the Sylvicultural Branch set out to obtain data for the preparation of volume and yield tables for some of the more important timbers such as teak, sal, and deodar, to mention but three of the best known throughout India. Selected sample plots of varying type and age had been previously formed by the forest officer in different parts of India, and more or less periodically measured and records kept. But for the most part the work was spasmodic and a proportion at least of the data obtained of doubtful usefulness.

As a result of the work inaugurated, attempts were made to prepare yield tables, among others, for the sal (*Shorea robusta*), such a table was prepared by Smythies and Howard and published in 1923. It was based on the measurements of some fifty-two plots of sal, chiefly in the United Provinces, with a few in Bengal and the Central Provinces. The sal has a wide distribution from the foothills and neighbouring border in the plains in the United Provinces as far west as the Jumna River, eastwards along this line through Nepal and Bengal Duars into Assam as far as Tezpur, its eastern boundary. To the south it is found in the eastern part of the Central Provinces and in Chota Nagpur, south-western Bengal, Orissa Province and Orissa Feudatory States to Ganjam in the Madras Provinces. It thus is equally at home in a dry hot as well as in a damp hot climate, and grows on a variety of soil conditions. Since the above tables were published, many more data have been collected, and this information has been collated in *Indian Forest Records* (Sylviculture) New Series, "Yield and Stand Tables for Sal (*Shorea robusta*) High Forest" (4A, No. 4, Model Press, Delhi, 1943) by M. L. Griffith, sylviculturist, and Bakhshi Sant Ram. The present tables are based on 542 measurements from 225 sample plots in twenty-five forest divisions of five provinces. Sample plot selection, upkeep and measurements in the different provinces are now greatly facilitated by the existence in the provinces of provincial sylvicultural research officers whose investigations and results are available to the Central Research Institute. That this departure is of the highest value is evidenced by the authors' remark, "The tables now produced are admittedly not completely satisfactory on account of the abnormality of some of the basic data. The main difficulties arose through inconsistent thinning procedure. These have been described in more detail together with the methods attempted to overcome them."

Just as the progress in ordered management of a forest department is indicated by the number of the forests which have been placed under working plans, including the type of plan in force, so the degree to which sylvicultural work has advanced is evidenced by the possibility of being able to prepare suitable yield and stand tables for use in the forests under management.

ADSORPTION OF WATER BY PROTEINS

IT is recognized that proteins contain two types of hydrophilic groups capable of binding water by hydrogen-bond formation, namely, polar side-chains such as those from lysine, glutamic acid, tyrosine, etc., and the oxygen and nitrogen associated with peptide bonds in the peptide chains. Adsorption curves are of the typical *S*-shape separable into three segments, the first part, at low pressures, characteristic of Langmuir adsorption, a second part with a more or less linear relation between adsorbed amount and vapour pressure, and a third part corresponding with a large increase of amount adsorbed with increase of vapour pressure.

H. B. Bull (*J. Amer. Chem. Soc.*, 66, 1499, 1944), who defines protein hydration as water released when moist protein in equilibrium with saturated water vapour at 25° or 40° is dried in vacuum for 24 hours at 105°, and calculates the free energy and heat changes in adsorption, concludes that the theory of multi-layer adsorption proposed by Brunauer, Emmett and Teller (*J. Amer. Chem. Soc.*, 60, 309, 1938) explains the results in a very satisfactory manner. This extends the Langmuir theory of mono-layer gaseous adsorption to the case where more than one layer of molecules are adsorbed, and the resulting curves were found to resemble those obtained in the experiments.

The results are believed to be consistent with the view that the protein molecules in the solid state are linked together to form coherent planes, the exposed surfaces of which are hydrophilic, and water is adsorbed between these planes. The final rise is thought to correspond with a saturation of exposed polar groups with water and the beginning of a process of solution of the protein. Heat coagulation of egg albumin seems to involve interaction between polar groups on neighbouring molecules, with a decrease in water-binding capacity.

It is thought that there is no direct relation between the amount of water held by a solid protein in a saturated atmosphere and the amount of water held by a protein when it is dissolved in water, the latter being mainly dependent on the total hydrophilic surface exposed to the water.

EFFECT OF MULCHING ON THE SOIL

MULCHING is a recognized method of conserving soil moisture, but often several other effects of the treatment are noticeable. This is not, of course, unexpected when the mulch consists of organic material containing soluble plant nutrients in greater or less amount.

I. W. Wander and J. H. Gourley¹ found that mulching with straw increased the contents of potassium, calcium, magnesium, phosphorus and boron in the soil, the effect being most marked for potassium, while H. Painter and G. F. Potter² report that with young tung trees mulching reduced signs of potassium deficiency, and C. E. Baker³ found a mulch as effective as dressings of muriate of potash in increasing the potassium content of apple and peach leaves. These results may not be due entirely to potassium supplied by the mulch, as C. E. Baker⁴

found that mulching with cinders or glass wool increased the potassium content of apple leaves, possibly because under the mulch a concentration of feeding roots near the soil surface, where potassium concentration is highest, occurred. Mulching with poor hay, also with apples, encouraged the production of surface feeding roots in addition to increasing soil moisture⁵.

The effects of mulching, however, are not always beneficial, and L. P. Latimer and A. P. Percival⁶ found that although hay or seaweed mulches, as compared with grass covering, increased growth and fruit sizes in apples, sawdust used as a mulch did not have this effect, but did increase fruit and decrease leaf colour, suggesting that it had induced a slight nitrogen deficiency. W. A. Johnson⁷, using sawdust as a surface mulch for tomatoes, found that it decreased the soil nitrate content slightly and when incorporated in the soil, as mulch materials usually are eventually, depressed the soil nitrate appreciably so that heavier nitrate applications were required. The sawdust conserved soil moisture and caused the soil to be less compact, but repeated sawdust mulches may have undesirable effects. L. M. Turk and N. L. Partridge⁸ found peat unsatisfactory as a mulch as it prevented light rain from reaching the soil, while loss by evaporation from the mulch continued. These ill-effects were not found when the mulch used allowed free percolation of water, and gravel, straw and sawdust were all effective in this respect.

¹ *Proc. Amer. Soc. Hort. Sci.*, 42, 1 (1943).

² *Proc. Amer. Soc. Hort. Sci.*, 42, 17 (1943).

³ *Proc. Amer. Soc. Hort. Sci.*, 39, 33 (1941).

⁴ *Proc. Amer. Soc. Hort. Sci.*, 43, 7 (1943).

⁵ *Proc. Amer. Soc. Hort. Sci.*, 42, 30 (1943).

⁶ *Proc. Amer. Soc. Hort. Sci.*, 44, 52 (1944).

⁷ *Proc. Amer. Soc. Hort. Sci.*, 44, 407 (1944).

⁸ *Proc. Amer. Soc. Hort. Sci.*, 38, 59 (1941).

FORTHCOMING EVENTS

Wednesday, April 4

SOCIETY OF PUBLIC ANALYSTS AND OTHER ANALYTICAL CHEMISTS (at the Chemical Society, Burlington House, Piccadilly, London, W. 1), at 5 p.m.—Mr. F. J. Macdonald "The Freezing Point of Sour Milk"; Dr. H. Liebmann and Mr. A. D. Ayres "The Electrometric Determination of Ascorbic Acid"; Mr. H. W. Webb "Magnetic Stirring in the Electro-Deposition of Metals".

INSTITUTION OF ELECTRICAL ENGINEERS (RADIO SECTION) (joint meeting with the TELEVISION SOCIETY) (at Savoy Place, Victoria Embankment, London, W. C. 2), at 5.30 p.m.—Mr. D. C. Birkinshaw and Mr. D. R. Campbell "Studio Technique in Television".

Thursday, April 5

INSTITUTION OF ELECTRICAL ENGINEERS (at Savoy Place, Victoria Embankment, London, W. C. 2), at 5.30 p.m.—Mr. L. J. C. Connell, Mr. O. W. Humphreys and Mr. J. L. Rycroft "The Place of Radiant, Dielectric and Eddy Current Heating in the Process Heating Field".

ROYAL AERONAUTICAL SOCIETY (at the Institution of Mechanical Engineers, Storey's Gate, St. James's Park, London, S. W. 1), at 6.30 p.m.—Dr. A. G. Pugsley "Modern Experimental Work on Aeroplane Structures".

Friday, April 6

INSTITUTION OF ELECTRICAL ENGINEERS (MEASUREMENTS SECTION) (at Savoy Place, Victoria Embankment, London, W. C. 2), at 5.30 p.m.—Discussion on "Are Engineers Losing their Sense of Proportion on the Accuracy of Industrial Measurements?" (to be opened by Mr. H. D. Hawkes).

INSTITUTE OF PHYSICS (SCOTTISH BRANCH) (in the Natural Philosophy Department, The University, Glasgow), at 7.30 p.m.—Dr. W. Hume-Rothery, F. R. S. "The Theoretical Interpretation of Alloy Structures".

Thursday, April 5—Monday, April 9

BRITISH PSYCHOLOGICAL SOCIETY (at the University College of the South West, Exeter)

Friday, April 6

At 9 30 a.m.—W. D. Furneaux "An Experimental Study of Suggestibility and Hypnosis", Wm. Fred Raphael "Surveys of Employee Attitude". At 11 20 a.m.—Hilda Lewinsky "Psychological Aspects of Cooking for Oneself", W. D. Wall "Reading Backwardness in the Army". At 5 p.m.—Margaret Lowenfeld "The Mosaic Test"

Saturday, April 7

At 9 30 a.m.—Discussion on "Psychological Implications of Culture Patterns" (Prof. T. H. Pear, Dr. A. I. Richards and other speakers). At 5 p.m.—Dr. Millais Culpin Presidential Address. At 8 30 p.m.—Display of Instructional Films arranged by the Visual Education Centre, University College, Exeter

Sunday, April 8

At 2 30 p.m.—An Account of the Work of the Devon Committee for Education in Mental Health and of the Committee of Professional Psychologists (Mental Health) of the British Psychological Society. At 5 p.m.—M. D. Vernon "Perception and Understanding of Graphical Material", Charles Burns "Types of Problem Children". At 8 30 p.m.—Alec Rodger "The Work of the Admiralty Psychologists", G. Patrick Meredith "The Problems and Methods of Visual Education"

Monday, April 9

At 9 30 a.m.—Eric Farmer "Problems in the Occupational Adjustment of the Blind", M. I. Dunsdon "The Binet Test as adapted for the Blind". At 11 20 a.m.—I. Langan "Demonstration of Binet Tests for Blind Children". At 11 50 a.m.—M. B. Stott "Some Differences between Boys and Girls in Vocational Guidance". At 5 p.m.—Dr. K. I. W. Craik "Refractory Period in Sensory-motor Action", H. Himmelweit "Level of Aspiration, as related to Neurosis and Temperament". At 8 30 p.m.—Open Session for Discussion

APPOINTMENTS VACANT

APPLICATIONS are invited for the following appointments on or before the dates mentioned

DEPUTY BOROUGH ELECTRICAL ENGINEER AND MANAGER to the Borough of Barking—The Ministry of Labour and National Service, Central (T and S) Register, Room 5/17, Sardinia Street, Kingsway, London, W.C.2 (quoting Reference No. D 1048 XA) (April 9)

GRADUATE TEACHER OF MECHANICAL OR ELECTRICAL ENGINEERING in the Southend Municipal College—The Chief Education Officer Education Office, Warrior Square, Southend-on-Sea (April 10)

PATENT AGENT, preferably specializing in ELECTRONICS, as Assistant in Patent Department—The Ministry of Labour and National Service, Appointments Department, Central (T and S) Register, Room 5/17, Sardinia Street, Kingsway, London, W.C.2 (quoting Reference No. F 3127 XA) (April 11)

MECHANICAL ENGINEER (fully qualified), in N.W. Area, by Engineering Company designing and constructing Electricity Generating Stations and Industrial Plants—The Ministry of Labour and National Service, Appointments Department, Central (T and S) Register, Room 5/17, Sardinia Street, Kingsway, London, W.C.2 (quoting Reference No. C 2512 XA) (April 12)

GRADUATE ASSISTANT LECTURER in the MECHANICAL ENGINEERING DEPARTMENT in the Coventry Technical College—The Director of Education, Council House, Coventry (April 16)

ASSISTANT LECTURER AND DEMONSTRATOR IN BOTANY—The Principal, Royal Holloway College, Englefield Green, Surrey (April 21)

LECTURER IN PHYSICAL AND INORGANIC CHEMISTRY—The Secretary and Registrar, The University, Bristol (April 23)

ORGANIC CHEMIST in the RESEARCH DEPARTMENT of a well-known firm in the London area, to carry out experimental work leading to the formulation of protective and decorative coatings for sheet-metal containers—The Ministry of Labour and National Service, Appointments Department, Central (T and S) Register, Room 5/17, Sardinia Street, Kingsway, London, W.C.2 (quoting Reference No. F 2719 XA) (April 26)

MECHANICAL AND ELECTRICAL ENGINEERS by the Gold Coast Government Public Works Department—The Ministry of Labour and National Service, Appointments Department, Central (T and S) Register, Room 5/17, Sardinia Street, Kingsway, London, W.C.2 (quoting Reference No. C 2526 A) (April 28)

CHAIR OF PHILOSOPHY in the University of Otago, Dunedin—The High Commissioner for New Zealand, 415 Strand, London, W.C.2 (April 28)

CHIEF ANALYTICAL CHEMIST in the RESEARCH DEPARTMENT of a well-known firm in the London area—The Ministry of Labour and National Service, Appointments Department, Central (T and S) Register, Room 5/17, Sardinia Street, Kingsway, London, W.C.2 (quoting Reference No. F 3073 XA) (April 28)

ASSISTANT SECRETARY to the INSTITUTE OF PHYSICS—The Secretary, Institute of Physics, c/o The University, Reading, Berks (April 28)

LECTURER IN ELECTRICAL ENGINEERING—The Registrar, The University, Sheffield (April 30)

METALLURGIST for a position in the RESEARCH DEPARTMENT of a large firm in Yorkshire—The Ministry of Labour and National Service, Appointments Department, Central (T and S) Register, Room 5/17, Sardinia Street, Kingsway, London, W.C.2 (quoting Reference No. F 2721 XA) (April 30)

KEEPER OF THE DEPARTMENT OF ZOOLOGY—The Director, Museum and Art Gallery, New Walk, Leicester (April 30)

METALLURGIST for a position in the RESEARCH DEPARTMENT of a large firm in South Wales—The Ministry of Labour and National Service, Appointments Department, Central (T and S) Register, Room 5/17, Sardinia Street, Kingsway, London, W.C.2 (quoting Reference No. F 2720 XA) (May 12)

PROFESSORSHIP OF MECHANICAL ENGINEERING—The Principal, Heriot-Watt College, Edinburgh (May 14)

UNIVERSITY CHAIR OF CHEMISTRY tenable at King's College—The Registrar, University of London, c/o Richmond College, Richmond, Surrey (May 18)

READERSHIP IN HUMAN PHYSIOLOGY—The Registrar, University Registry, Oxford (June 16)

KEEPER OF THE DEPARTMENT OF ART—The Director, National Museum of Wales, Cardiff (June 30)

GEOLOGIST to the Government of Trinidad to co-ordinate geological information, compile geological map after necessary surveys and advise on geological questions connected with petroleum industry development in the Colony—The Ministry of Labour and National Service, Central (T and S) Register, Room 5/17, Sardinia Street, Kingsway, London, W.C.2 (quoting Reference No. F 3769 A) (August 31)

MECHANICAL INSPECTOR OF WORKS (temporary) by the Government of Sierra Leone for the Electricity Branch of the Public Works Department—The Ministry of Labour and National Service, Appointments Department, A 3(A), Sardinia Street, Kingsway, London, W.C.2 (quoting Reference No. O S 605)

EDITORIAL ASSISTANT by British Council to help in production of a monthly journal published in several languages—The Ministry of Labour and National Service, Appointments Department, A 3(A), Sardinia Street, Kingsway, London, W.C.2 (quoting Reference No. P Q 144)

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Great Britain and Ireland

Medical Research Council Industrial Health Research Board Report No. 87 "The Relation between Illumination and Visual Efficiency—the Effect of Brightness Contrast" By H. C. Weston Pp 36 (London H.M. Stationery Office, 1945) 6d net [272]

University of Birmingham Report of the Vice-Chancellor and Principal to the Council, for the Calendar Year 1944, with an Appendix containing an Analysis of Student Numbers in the Forty-fourth Session, 1943-1944 Pp 22 (Birmingham The University, 1945) [13]

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U.S. Department of Agriculture Miscellaneous Publication No. 531 "A Review of Studies on the Mexican Fruitfly and related Mexican Species" By A. C. Baker, W. E. Stone, C. C. Plummer and M. McPhail Pp 155 (Washington, D.C. Government Printing Office, 1944) 35 cents [222]

Annals of the New York Academy of Sciences Vol. 45, Art. 9 "Energy Relationships in Enzyme Reactions" By Joseph S. Fruton, Eric G. Bal, Max Bergmann, Herman M. Kalckar, Otto Meyerhof and Carl V. Smythe Pp 357-436 (New York New York Academy of Sciences, 1944) [272]

National Research Council American Geophysical Union Transactions of 1944 Part 1 Reports and Papers, Joint Regional Meeting, Section of Hydrology (South Pacific Area), Western Snow-Conference, American Society of Agricultural Engineers (Pacific Coast Section), Berkeley, California, February 17-18, 1944 Pp 188 (Washington, D.C. National Academy of Sciences, 1944) 2 dollars [272]

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Catalogue

Hospital Physicists' Association Diagrams and Data Subcommittee Catalogue A Being a list of Diagrams, Data, etc., of which copies can be supplied, and of Books (not easily obtainable) the loan of which can be arranged (London John Read, Hon. Secretary, Radiotherapy Department, London Hospital, E.1, 1944)

NATURE

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INTERDEPARTMENTAL CO-OPERATION IN RESEARCH

AN account of what is being done in America in the broad field of experimental human biology to promote co-operative research has been given in a recent paper on "General Aspects of Interdisciplinary Research in Experimental Human Biology" by Dr. Josef Brozek and Prof. Ancel Keys, of the University of Minnesota (*Science*, 100, 507, 1944). This paper, apart from its specialized interest, is of wide importance in that it indicates some of the fundamental problems of the most effective organization of research effort everywhere, and it is a valuable contribution to constructive thought on the unity of knowledge. It will be recalled that the Manchester Literary and Philosophical Society recently devoted a meeting to this subject, and to the means of redressing that progressive disintegration which, as Prof T W Manson emphasized, is such a characteristic feature of our civilization.

Dr. Brozek and Prof. Keys direct attention to some of the implications of the attempt to develop in the academic field the co-operative attack on problems by whole groups of specialists such as physicists, biochemists, bacteriologists, nutritionists, pathologists, physiologists, histologists, and psychologists. At present, competition between university departments may create a barrier to interdepartmental work. Again, it is pointed out by Dr M A. May, director of the Yale Institute of Human Relations, that the departmental method tends to encourage individualism and to discourage the ambitious worker from participating in interdepartmental collaborative projects. A third barrier is formed by traditional attitudes and ideas, such as the belief that scientific discoveries are always the products of individual minds, or that the co-operative setting limits the freedom of the scientific worker to follow the dictates of his own intellectual curiosity. A fourth barrier results from university training in habits of individual work.

As a result, Dr Brozek and Prof Keys point out, the young scientific worker is poorly prepared to participate in the activities of a committee or a research team. He may have become skilful in gathering empirical data within his own narrow field, but his techniques of social interaction are undeveloped and ineffective in practice. The Yale Institute of Human Relations was created more than a decade ago to meet this need for bridging several anthropological disciplines. The purpose was to correlate knowledge and co-ordinate technique in related fields, so that greater progress may be made in the understanding of human life from the biological, psychological and sociological points of view. Since 1930 other university institutes have been organized on inter-disciplinary lines, and Dr Brozek and Prof. Keys strongly urge that such developments should form a part of graduate schools and not be left to industrial organizations, which will rarely provide the time and personnel to carry out a training programme of high scientific standing.

There can be little doubt that Dr Brozek and Prof Keys are on firm ground in urging that more should be done to break down departmentalism and encourage the attack on fundamental problems by workers in different branches of science. That idea was clearly present in the discussions at the recent British Association Conference on Science and Industry, but industrial experience as a whole scarcely suggests that the average research worker finds it as difficult to fit into an interdisciplinary team as the present paper implies. Both the competitive and co-operative habits can be encouraged in the process of learning, but much also depends on the personality of the individual worker.

The real case for stimulating supervision of the type here suggested, with its consciousness of scientific and social responsibilities, is the spur it gives to creative thought at the borderline of the sciences concerned. That as well as the encouragement of habits of co-operation and understanding is the outcome of broadening the background of the student and integrating the discipline he primarily follows more closely with the field of knowledge as a whole. Dr Brozek and Prof Keys rightly point to the value in this respect of a course in the philosophy of science, and they stress particularly the importance of including the theory of meaning and the study of verbal and non-verbal symbols used in representing scientific concepts and their combinations, the logic of the scientific method which deals with experimental design, collection of data, analysis of the error of measurement, process of inference and testing of hypothesis, and the concrete logic or systematology of the sciences based on analysis of their subject-matter and methods used.

Much of course would depend on the way in which such philosophy is taught, but beyond this, stress is laid on the necessity of working facilities for getting acquainted with the problems and methods of neighbouring fields, and familiarity with current problems. These, in fact, rather than the development of social skills, are the essential factors for stimulating an effective scientific co-operation, but in actual practice the methods and organization developed at the Laboratory of Physiological Hygiene at the University of Minnesota do not appear to overstress the third factor, and they provide ample encouragement for individual initiative and personal responsibility. It is worth recalling that something of the same kind of plea for the teaching of philosophy was voiced in respect of engineering at a Conference on Industry and University Education held last December in London by the Vacation Work Committee of the Imperial College of Science and Technology (see *Nature*, March 31, p. 402), and the article on "The Churches and European Reconstruction" which the Bishop of Chichester contributed to a recent number of the *Contemporary Review* is important for the same emphasis that is laid on the need for a spiritual unifying force, to be found not merely in science, which will restore hope and purpose.

This emphasis on the importance of the unity of knowledge is to be found in other discussions which

have centred around the universities and their functions in the modern world. Prof Manson's address, referred to above, was largely concerned with the part which the universities might play in restoring a measure of unity to civilization if they set their own house in order by clearing themselves of the charge which the late Archbishop of Canterbury once levelled against them in a sermon before the University of Oxford, that a university "is a place where a multitude of studies are conducted, with no relationship between them except those of simultaneity and juxtaposition". That is a problem which must be frankly faced in dealing with the reconstruction and expansion of the universities. It is germane to the fundamental questions as to the functions of the universities and their place in the society of to-day, and was indeed frankly faced by both Dr Lowe in "The Universities in Transformation" and by F. R. Leavis in "Education and the University".

More recently, the whole question has been very concisely but admirably discussed by Prof. John Macmurray in his article "The Functions of a University" in the *Political Quarterly*. Prof. Macmurray, stressing the cultural function of a university as the key to its functions of research and of teaching, urges that the life of a university should be effectively bound up with that of society about it. This cultural function cannot be fulfilled decisively unless the university is a place where knowledge is unified and not merely a common house for disjointed specialisms, and unless this unification is in constant and vital relation to the cultural life in the community around the university. A university must be designed to encourage and facilitate the interchange of knowledge through which it can become a spiritual whole, but the departments of knowledge can only be unified in the active life of a human community.

It is in this cultural function that our universities are most conspicuously failing, and that is essentially the point of Mr A. S. Nash's criticism in his more recent book "The University in the Modern World". Prof. Macmurray lays the responsibility for this failure rather on the disintegration of traditional culture than on the universities themselves, and although he makes no suggestions as to how these three functions can be effectively discharged under modern conditions, he looks forward with some confidence. The use of science for social ends demands a unity of purpose in society which must express itself in, and depend upon, the achievement of a cultural synthesis. Changes in social structure and social outlook are taking place which will alter the demands made upon all our educational and cultural institutions, and Prof. Macmurray looks to a period of social and cultural unification. His paper, no less than that of Dr. Brozek and Prof. Keys, is a challenge to the critical and constructive thinking on the ultimate functions of the university and its place in modern society which must precede the adaptation and re-organization of its structure and methods, so as to serve these aims and functions more effectively in the new age.

A LANDMARK IN ALGOLOGY

The Structure and Reproduction of the Algae

By Prof F E Fritsch, Vol 2 Foreword, Phaeophyceae, Rhodophyceae, Myxophyceae Pp xiv + 939 (Cambridge At the University Press, 1945) 50s net

WITH the publication of this volume the whole botanical world, and algologists in particular, owe a special debt of gratitude to Prof Fritsch. Although ten years have elapsed since the appearance of the first volume, it is no mean achievement under present conditions to have produced this companion work, and both Prof Fritsch and the Cambridge University Press are to be congratulated on their courage and determination.

The two volumes virtually represent Oltmann's brought up to date and greatly expanded, and they will undoubtedly form the algologist's *vade mecum* for many years to come. Considerable advances have been made since the last edition of Oltmann's was published, and a new work, preferably in the English language, was plainly demanded. The labour involved in the preparation and execution of such a task is enormous, and Prof. Fritsch can look back with every satisfaction upon his handiwork. This and the companion volume alone would ensure him the immortality of the earlier great algologists.

The real reward for producing such a book must ultimately lie not only in the stimulus it gives to research but also in its influence in directing future research. This second volume should exert a profound effect upon both. The publication of such a book is obviously the moment to reflect upon the present position of algology. It is clear that in recent years the principal advances in the morphology of the brown algae have been mainly in certain groups, for example, Fucales, Ectocarpales, whereas in others, for example, Laminariales, there has been little further progress. In the Rhodophyceae the extensive work of Kylin and other Scandinavians has opened up much that was unknown, the frequent use of Kylin's figures being eloquent testimony of his contributions. In reading the present volume one cannot but be impressed by the extensive advances in knowledge, but at the same time the remaining lacunae obtrude upon our notice. In general, more work is needed, especially by those favourably placed, upon tropical and southern hemisphere genera. In particular, *Apakpus*, *Arthrocladia*, *Adenocystis*, *Dictyotopsis* and *Padina* among the Phaeophyceae need further study, the Encelaceae, Tilopteridales and extra-European Sporocnales have many secrets still to yield, and cytological investigation is sorely required in *Soranthera*, *Ascocyclus*, *Ectocarpus Lebelii* and *Sphacelaria*. Similarly in the Rhodophyceae, outstanding problems could be assisted by a study of the development of *Delesseria* and *Nitopyllum*, and by investigations of the genus *Compsopogon*, the Sarcomenae and the parasitic Florideae as a whole. The cytology of *Galaxaura* and the Gelidiales is practically untouched, and the absence of female plants in *Rhodymenia palmata* and *Halosaccoramentaceum* is no mean problem. In the Myxophyceae, the Entophysalidaceae and Pleurocapsales are most in need of attention. The above are just a few of the lacunae that need to be filled.

The concept of heterotrichy, one of Prof. Fritsch's greatest personal contributions to algology, pervades the volume, and for the first time one can see it in

full perspective. Here one regrets that Prof Fritsch's four recent studies in comparative algal morphology were not included in this volume, because they form a summary of the valuable material contained in this book. It is still painfully evident that we are no nearer solving the puzzle of the origin of the Phaeophyceae and Rhodophyceae. On the other hand, recent cytological work suggests that we might well abandon the old concept of alternation of generations and refer rather to alternation of phases (*v* Drew, *Ann. Bot., Lond.*, NS 7, 23, 1943). In this connexion one feels that the term triplobiont might well have been introduced, as indeed it has been by Drew, to cover those cases among the Rhodophyceae with a triploid phase. Thus the statement on page 415 that the remaining Rhodophyceae are diplobiontic is somewhat misleading.

I am not certain that the fundamental change of arrangement adopted for the treatment of the Rhodophyceae is advantageous, because in some cases members of the same family (for example, Corallinales) are treated pages apart. This, however, is not necessarily an opinion that will be shared by others.

It is a vain hope these days for authors not to expect their books to become out of date in minor details almost before they are published. Thus, the freshwater Phaeophyceae are no longer restricted to the Ectocarpales, for in 1943 a freshwater member of the Sphacelariales was reported from China, while in the same year David published an important contribution on the growth and ecology of *Ascophyllum*.

For most research workers the intrinsic value of this book will lie in the magnificent collection of references to the extensive literature. Here everyone will acknowledge the great debt we owe to Prof Fritsch. The author says that the section on ecology is not exhaustive, but at the same time one would have liked to see some reference to Bokenham's work on algal recolonization, and also to the splendid series of biotic studies of the South African intertidal zone by Stephenson and his co-workers, whose results are independent of those of Isaac. In the section on salt marsh fucoids, there is no reference to two relevant papers on American salt marsh algae. In other parts of the book the important review paper by Hoffmann on the utilization of seaweeds is missing, and there is also more recent literature than that quoted on alginic acid and agar. Morphologically, the principal omission is the important work of Kirjeva and Shapora on growth and reproduction of *Laminaria* in Kola Fiord, while the work of Zimova on the same genus is also not mentioned. In the genus *Dictyota*, Collins, as well as Holden, has recorded the presence of antheridia and tetraspores on the same plants in one species, *D. indica*, the tetraspores not undergoing normal division.

In a work of this magnitude it is inevitable that small points should be overlooked, but this reflects no discredit on the author; rather the reverse because, although the field is so vast, the omissions are almost negligible. However, one would like to have seen some reference to the morphology of those interesting endophytes, *Schmatzella mirabilis* and *Rhodochorton endozoicum*. Some reference might also have been desirable to the three physiological races of *Laminaria cloustoni* described by Montfort, further, there is no mention of the galls caused by the nematode *Tylenchus fucicola* on *Ascophyllum* and *Desmarestia*, although there is a reference to similar galls in the Rhodophyceae. Mention is made of the use of brown algae for the

manufacture of potash, but this industry really commenced with the use of the Fuci as a source of soda for glass and glazing. *Rhodymena palmata* with 0.7 per cent iodine contains more than *Trachella*, while *Phyllophora nervosa* is so rich in this element that the Russians use it as a commercial source of iodine. Some of the algae are also richer in protein than is indicated, for example, *Porphyra tenera* (28 per cent) and *Undaria pinnatifida* (11 per cent).

The great care expended by Prof. Fritsch on this work is seen in the almost entire lack of printing errors. The most important of these are several references to Maps 1 and 2, said respectively to be on pp. 8 and 250, whereas both are at the end of the volume. The footnote on the reproduction of *Hildenbrandia rivularis* is somewhat confusing, and in conjunction with the text leads one to think that the genus has no reproductive organs. Nearly all the numerous illustrations are of excellent quality, but it is evident that some, for example, Figs. 6 D, 36 A, 91 G, 199 H and 289 E have suffered severely in reduction, and the photographs, Figs. 64 and 117 B, also are not very clear.

All these points, however, are but minor details in a volume that is of first-class importance. Its production has restored the prestige of English algology built up by the workers of the last century. It is a volume that all who can afford it should possess, and no library should be without it. The Cambridge University Press is also entitled to congratulations on producing such a well-constructed book in wartime.

V. J. CHAPMAN

TWO FARMERS LOOK BACK

Farming Memoirs of a West Country Yeoman
By S. G. Kendall. Pp. 247. (London: Faber and Faber, Ltd., 1944.) 12s. 6d. net.

Thirty Years Farming on the Clifton Park System
How to Supply Humus, Texture and Fertility by the aid of Deep-Rooting Grasses. By William Lamm. Pp. 110+3 plates. (London: Faber and Faber, Ltd., 1944.) 7s. 6d. net.

ANYONE who knows an English village well knows that there is usually someone with a gift for telling a story, developed perhaps in the friendly atmosphere of the 'farmers' ordinary', or even in the alehouse or in the camaraderie of farm work. Some combine this with another gift, the ability to put the story into writing. In recent years there have been many discoveries of these talented people, and they have been encouraged to write down what they have to say. Messrs. Faber and Faber have been particularly successful in finding some of these men and they have recently issued several books, each a first effort, by a farmer whose story would otherwise never have got beyond his own village.

One of the latest is the "Farming Memoirs of a West Country Yeoman" by S. G. Kendall. It is in many ways a remarkable production. Mr. Kendall has been farming all his life near Bath, as his father and grandfather had done before him. He is now nearly eighty-six, so that the joint lives of all three stretch over a considerable period. He begins his book with an account of the disastrously wet harvest of 1860, when the grain sprouted badly in the stook and the flour yielded a dough which would neither rise nor bake properly, so that the inside of the loaf was stodgy and sticky with a sickly, sweet, un-

palatable flavour. Two knives had to be used, one for the actual cutting, the other to clean the first knife before it would cut again. But the housewives of those days were very ingenious: they met the difficulty by leaching wood ashes with boiling water, allowing the insoluble material to settle, and taking off the clear liquid (which was mainly a solution of potassium carbonate) and using it for making the dough. The improvement was considerable, though the result was still not entirely satisfactory.

In those early days the main products of a Wiltshire farm were sheep and corn. The dairy cows were let to a dairyman at a certain price per head per annum; he tended them, made butter or cheddar cheese, in addition, he could keep as many pigs as the accommodation permitted. The farmer replaced any cows that died and provided some of the milkmen.

Agriculturists will read with interest the author's short summaries of the various seasons. 1874 was the peak of success: yields of corn were good, prices were "fairly remunerative", while values of beef, mutton, milk, butter and cheese all steadily increased—the result, in his view, of the Franco-German war. A considerable amount of labour was needed, but it was always forthcoming, the men worked well and willingly. Hours were very long: work in harvest time began at 3 a.m. and went on until dusk; wages were low—13s.—15s. a week—families were often large, and at the end of a strenuous life the workers could look forward only to the workhouse, or, if they wished to stay outside, to a Poor Law pension of 2s. 6d.—4s. a week with or without a loaf of bread. During their working lives there were, of course, compensations: Harvest Homes, Christmas feasts, fairs, etc., and clearly the workers enjoyed life, but undeniably it was very hard. Their diet must have been good, for they were very strong.

The year 1877 was not a bad season; wheat sold at £3 per quarter. The worst season of the nineteenth century was 1879 by reason of its cold, wet summer and harvest, and in the following season, 1880, there were considerable sheep troubles. 1881 was better so far as yields and quality were concerned, but prices were falling; by 1886 the combination of bad seasons and low prices had forced many farmers out of business and many farms were derelict. 1891 and 1892 were both difficult years, 1893 was second only to 1879 for utter badness, but this time it was from excessive drought—a most unusual cause for low yields of grain. To make matters worse, prices collapsed—the result of a financial crisis in the western States—and the miserable yields of wheat sold for only 23s. a quarter, sheep and lamb prices were also low. Things improved later, and Mr. Kendall was able to keep going.

The agricultural details, however, are only part of the interest of the book. It is a very human document, and Mr. Kendall has a keen eye for the beauty of the countryside and a very lively interest in the doings of country people. So he gives accounts of feasts and weddings, of dances, skating and political meetings in barns, of exciting rescues of cattle from a disastrous flood and of sheep from a severe snow storm, and of other events—all written in a vivid, sometimes eloquent, style and interspersed with a wide range of quotations from "Alice", Southey, Burns, Charles Kingsley and others. He modestly does not publish photographs of himself, but we can perhaps picture him as the modern counterpart of another but much earlier nineteenth-century farmer also a great reader of poetry with an eye for the

beauties of Nature—Mrs Gaskell's "Thomas Holbrook". The general reader will enjoy the book as much as the agriculturist

Mr Lamin's book is altogether different in character. It is written for farmers by a farmer, though its scope is a good deal wider than the title indicates. He also is well over eighty years old, he writes clearly and he has a good story to tell. The son of a farmer, he worked on his father's farm near Nottingham until he was twenty-four, when his father set him up as a butcher. 'But the call of the land was too strong, and after five years he took the farm next to his father's a poor, run-out sandy stretch, its soil liable to be blown away in a high wind, washed away in high rain, or scorched on a hot day. It had been unlet for nineteen years. He struggled on for five or six years, then came across Mr R. H. Elliot's book describing the system followed at Clifton Park. This book made a great stir in its day, and it is still useful now. Messrs Faber and Faber have, in fact, re-issued it. Like other agriculturists of his time, Mr. Elliot did not think the sub-soil on his land was adequately treated, and in his seeds mixture he included some deep-rooting plants that would open it up. The idea appealed very much to Mr Lamin, and he thought that if he could get enough fibrous root material into the surface and the subsoil of his farm he would not only fix the soil but so enrich it in humus that he would greatly increase its productiveness. So he evolved a seeds mixture on Elliot's lines including cocksfoot, meadow fescue, rough-stalked meadow grass, Montgomery red, Aberystwyth white and Kentish white clovers; chicory, burnet, yarrow and sheep's parsley. This was left down for four years and each year gave excellent crops, finally leaving the soil enriched with a good turf and a mass of deep roots that not only stopped the loss by blowing away and washing, but also made an admirable foundation for the succeeding crops. oats, potatoes, silage crops, etc. He would not, however, include rye grass in his mixtures.

Mr Lamin used artificial fertilizers liberally, and has some rather scathing things to say about those who claim that they are ineffective or even harmful.

The book contains a great number of practical details of considerable agronomic interest and not easily accessible elsewhere, and it records an achievement of which Mr. Lamin may well be proud.

E. JOHN RUSSELL

THE COUNTRY TOWN

Country Towns in the Future England

A Report of the Conference representing Local Authorities, Arts and Amenities Organizations and Members of the Town and Country Planning Association on the 23rd of October, 1943. Edited by Stanley Baron. Pp 140 (London: Faber and Faber, 1944) 8s 6d. net.

THE main title of this book is somewhat of a misnomer. The book is a straightforward report of a conference held in the autumn of 1943 under the auspices of the Town and Country Planning Association, at which representatives of some ten per cent of the smaller towns of England were told how to plan to get more industry and better amenities into their boroughs. Short speeches were made by representatives of five of the towns themselves: a health resort (Malvern), a garrison town (Richmond,

Yorks), an agricultural centre (Wisbech), a 'one-industry' weaving town (Haslingden) and a moribund ancient borough (Brackley). Conditions were very different, but all advocated the same solution—new light industries.

It was left for Prof Ashby, in opening a discussion, to make much the most important contribution to the conference and to this book. He carefully analysed the reforms that the small country towns must undertake before they can become attractive habitats for the staffs of decentralized industry. He also reminded the conference that in the last resort the economic welfare of the country town is dependent on the well-being of its surrounding agricultural and village communities. The primary requirements of a country town are suitable facilities for marketing agricultural produce, adequate transport arrangements for goods and passengers, a full range of supply services in agricultural requirements, a choice of banking services, a full range of supply of retail shopping facilities; a choice of good repair and maintenance garages; an adequate supply of cafés and restaurants, an adequate supply of hotels, as well as of public houses; at least one good cinema; and provision for technical education. The smallest town able to provide these requirements in full would have at least 7,000 inhabitants, and more often 10,000.

The course of action that should be followed by country towns which wish to attract industry was outlined by Mr. R. L. Reiss, deputy chairman of Welwyn Garden City, and Mr. T. A. L. Paton. They put forward the following desiderata: grouping of factories to spread costs of public utility services, good road communications, building sites at least 200 ft deep and 100 ft. wide, the building line set back 25 ft. from a 50-ft road, railway sidings for a few larger factories, which must have sites at least 700 ft deep, single-story factories built to rent, each with a 40-ft frontage and depths varying from 65 ft. to 100 ft., building to cover only 20 per cent of the total area of the industrial estate when fully developed in order to leave sufficient elasticity for necessary expansions and avoid the creation of a factory slum. Pre-war development costs were £800–£2,000 an acre before the first brick of a factory was laid.

The third session was devoted to amenities and was addressed by Miss Glasgow, secretary of the Council for the Encouragement of Music and the Arts. She said that places of about 30,000 population should be able to support a theatre seating 700–800, a concert hall, a library, an exhibition gallery and several cinemas. In towns of some 20,000, the theatre would probably also have to serve as a concert hall and public meeting place, and might well have an exhibition gallery as an annexe. With less than 10,000 people, townships could only support a community centre, this should not consist of one elaborately equipped hall, but of a group of smallish rooms to form a library, an art room, a little theatre and a music room.

In the book these constructive suggestions are surrounded by much general discussion, but the whole makes interesting reading, and (together with the National Council of Social Service report "Dispersal") is a useful corrective to the view that the re-location of industry can be settled by engineers, based on the suitability of each site from considerations of raw materials, transport and markets.

J. TYRWHITT.

NATURAL HISTORY OF GRANITE

By PROF. ARTHUR HOLMES, F.R.S.

FOR a century and a half the origin of granite (including granodiorite) has remained one of the most intractable and controversial of the problems geologists have tried to solve. Fouqué and Levy's comment in 1882, that "it excites the most lively discussion", is as true to-day as ever before, and indeed might be regarded in some countries as a mild understatement of the passions that are aroused by apparent conflicts of evidence and very real conflicts of opinion. Hutton clearly established the status of granite as a crystalline plutonic rock, but the French geologists and Lyell and his followers soon realized that not all granites are necessarily of igneous origin. Some occurrences were seen to have no sharp contact against the aureole of metamorphic rocks, but to merge into the surrounding schists through a transitional zone of gneisses and feldspathized schists so gradually that at no point could it be said that the rock ceased to be metamorphic and became igneous. These granites consequently came to be regarded, not as representing the cause of metamorphism, but as being the extreme products of its action.

Discussion thus became focused on the question whether a given mass of granite had crystallized from an intrusive magma which mechanically displaced the pre-existing rocks, or whether the granite had been made out of the pre-existing rocks by some process of ultra-metamorphism which was thought to culminate locally in actual fusion. The extreme magmatists have since come to admit that magma may react with the invaded rocks and assimilate the products, while adherents of the metamorphic view have realized that chemical changes are essential for the formation of granite, and that the pre-existing rocks must therefore have been permeated by granite magma or its derivatives (including the *ichor* of Sederholm and the hydrothermal solutions favoured in America), or by more tenuous migrating materials of unspecified origin, referred to as mineralizing agents or emanations. Between these limits of interpretation, many grades of opinion have been held, especially as regards the origin of granite magmas. Those who insist that all granites are igneous accept granite magma as having been available, either in its own right or, more recently, as a residual magma thought to have been derived by fractional crystallization from an antecedent basaltic magma. Those who regard granites as having been largely formed from the pre-existing rocks recognize that they passed through a stage when part of the material was mobile or fluid. The partially fluid mash has been styled *magma* by Reinhard, to distinguish it from a mash consisting of incompletely crystallized magma. Moreover, magma may be generated from magma either by the attainment of complete fluidity or, at any stage, by the squeezing out of the fluid portion.

It is unfortunately not generally realized that the battle between rival camps has been repeated more than once, with varying fortunes at different times and in different countries. Most of the older English-speaking petrologists of to-day were brought up, like myself, in the faith that granite, being by definition an igneous rock, must have crystallized from a magma; and many of us have had to rediscover for ourselves that the plutonic characters of granite are not in themselves a guarantee of igneous origin. A fact, long overlooked, to which Scheerer had already

specifically directed attention so early as 1847. Still worse, we were left in ignorance of the stimulating ideas of the French school, or with the impression that they were old-fashioned and unworthy of serious consideration. Looking back, it is obvious that a carefully balanced historical introduction would have dispersed the fog of dogma and prejudice in which we were unconsciously groping. But no one had undertaken the arduous task of preparing such a survey, and in its absence enlightenment was slow and largely dependent on the luck of one's personal experience in the field. Iddings¹, it is true, had published a historical review of the origin of igneous rocks in 1892, but this dealt mainly with volcanic rocks and their magmas, and neither the problems associated with granite nor the achievements of the French school were as much as mentioned. Now, half a century later, full amends have been made to the masters of the past in two illuminating presidential addresses delivered by Prof. H. H. Read² to the Geologists' Association, the keynote being Hutton's remark "I have been particularly anxious about this subject of granite". Fortunately, our historian has a background of field experience that ensures sympathetic and competent judgments. Inevitably he holds up the mirror to himself as well as to others, but only to reveal himself as a good-humoured guide who neither claims authority nor acknowledges any, save only in the rocks themselves.

One of the 'high lights' of the story is the record of the great contributions made by the French, a record which anticipates in the most remarkable way the more detailed developments of recent years. In 1824 we find Ami Boué describing what would now be called granitization, and suggesting that the passage through crystalline schists of heat and gaseous exudations from the earth's interior was responsible for the growth of veins and disseminated crystals, and eventually for "a kind of igneous liquefaction". In 1837-38 Fournet distinguishes metamorphic rocks due to simple recrystallization from others in which partial melting has occurred, combined on occasion with inward and outward migrations of material. In 1841 Deville introduces the idea of mineralizing agents—gases which carry mineral matter and so chemically transform (as we should now say, by metasomatism) the rock substances through which they diffuse. In 1844 Virlet d'Aoust uses the term *imbibition* to express the idea that igneous materials have soaked into metamorphosed sedimentary rocks and transformed them into granite. Shortly afterwards, in 1847, he speaks of the process as *granitification*. In the same year, Fournet notes that, in certain metamorphosed sediments, far more felspar has developed than could possibly be accounted for by simple recrystallization, and so provides evidence that introduction of material must have taken place. In 1869 Delesse submits the hypothesis that granitized plutonic rocks may become so mobile that they can be squeezed towards the surface, to form intrusive granites at high levels in the crust, where they may have lost all the characters from which their true origin could be determined.

Before considering one of the major turning points in the history of petrogenesis which was now approaching, it is of interest to see what was happening in the British Isles during the rise of the French school. Following Lyell's suggestion, 'metamorphic' granites had been widely claimed in Scotland and Ireland, but more stress was given to heat and fusion, partial

or complete, than to change of composition and fluxing by introduced materials. In 1862 Scott and Haughton advocated a twofold origin for the granitic rocks of Donegal, of which they recognized both metamorphic and intrusive varieties. In 1871 Green³ described the vestiges of bedding that visibly remain in the granite of the Errigal district, and suggested that in places these ghost-like structures had been destroyed by fusion, and that the fused material, in virtue of its superior mobility, had behaved intrusively. The objection that in order to convert sedimentary rocks into granite certain missing substances would have to be restored was apparently not realized. A few years later this difficulty was independently faced by Clifton Ward (1876) on lines that the French work should already have made familiar. Discussing the origin of the granites of the Lake District, he writes: "Although a simple melting down might never produce granite, yet a moist fusion, accompanied by elementary substances, brought upwards from still greater depths, might effect a great transformation." Ward's suggestion was stillborn, and the old ideas lingered on in Ireland until adverse criticism from Callaway⁴ and Bonney, whose sympathies were with Rosenbusch, finally banished 'metamorphic' granite from the pages of the memoirs of the Irish Survey.

The critical year appears to have been 1877, when Rosenbusch⁵ published his classic work on the contact metamorphism of the slates around the granite of Barr-Andlau (Vosges) and showed by a series of chemical analyses that there was no significant change of composition in the altered rocks as they were traced towards the margin of the granite. Having found in this example no evidence of transfer of material into the country rocks, Rosenbusch afterwards denied the very possibility of such permeation, and claimed that the gneisses and feldspathized schists which elsewhere appeared to demand introduction of granite-making substances were themselves merely granites that had suffered dynamic metamorphism during orogenic movements. Like Werner, Rosenbusch attracted from abroad many students who afterwards achieved fame, and so great was his authority—outside France—that his doctrines dominated petrological opinion for two generations.

The French, however, did not allow their case to go by default. Barrois (Rostrenon, 1884), Michel Levy (Flammanville, 1893), and Lacroix (Pyrenees, 1898–1900) found large, well-shaped crystals of orthoclase, identical with those of the adjoining porphyritic granite, not only in the sedimentary schists outside the granite, but also in enclaves of similar material occurring within the granite. Neither the feldspars nor the granites show any sign of dynamic metamorphism, and the structures are entirely different from those of, say, the Mont Blanc granite, which has demonstrably been sheared. The crucial nature of the evidence provided by the 'big feldspars' has long been realized, since no one has seriously doubted that they must all have shared a common origin. Either they grew in solid rock or they crystallized from a magma. Identical feldspars could not be assumed to have originated in two entirely different physico-chemical environments. Those who believed that they could form only by crystallization from a magma resorted to various expedients to avoid the disturbing implications of their presence in contact zones and enclaves. Rosenbusch stubbornly maintained his earlier interpretation, to the justifiable astonishment of Lacroix. Actually, the possibility of transfer of

silicate-making materials was never widely admitted until the publication of Goldschmidt's proof (1921) that influx of silica and soda had accompanied the contact metamorphism of pelitic rocks in the Stavanger area. Before this convincing demonstration, and even afterwards, Cole⁶ (1915) and Thomas and Campbell Smith (1932), among others, took refuge in the unmanageable hypothesis that the big feldspars had somehow been bodily introduced from an assumed magmatic source. A fatal objection to this awkward idea is that the feldspars are to be found in obviously sedimentary contacts and enclaves, among which, as Read points out, there are examples where "delicate bedding displayed often in three dimensions, is not disturbed in the least." Innumerable exposures show that the feldspars cannot have been introduced mechanically. Harker ignored or minimized the evidence, and many other petrologists preferred to remain silent on the matter, presumably because they had nothing to say about what could not be understood. Nevertheless, a definite and far-reaching conclusion can be drawn in all cases where it can be established—as it generally can—that the feldspars did not grow as 'porphyritic' crystals of post-granite formation. To quote Read: "Where the xenoliths [enclaves] containing the feldspars are sedimentary, then what encloses the xenoliths and similar feldspars is also sedimentary—the porphyritic granites are produced from the sediments by an intensification of the feldspathization process", and, he pertinently adds, no one can demonstrate a magmatic origin for the porphyritic granite which contains the 'xenoliths'.

Meanwhile, as a result of several comparative studies of feldspathization and granitization, the French geologists became convinced that these processes increase in intensity downwards until the contact zones of the higher crustal levels merge into regions where the rocks have been quietly made over into granite without significant disturbance of the pre-existing strata. Both Michel Levy and Lacroix thought of the active agent as granite magma, but Lacroix makes it clear that the magma must have been chemically and physically very different from merely molten granite, since it generates granite only after incorporating the schists that were there before the granite. Termier (1904 and 1910) developed this conception to its logical conclusion by pointing out that the active magma envisaged by Lacroix could itself be accounted for in terms of pre-existing rocks and highly energized emanations. He speaks of the latter as *colonnes filtrantes*, which rise from the depths into, say, geosynclinal strata, adding energy and exchanging new elements for old as they ascend and spread out. Where the intensity is greatest the rocks are granitized and locally transformed into magma, while the displaced elements are driven forward with the other migrating materials in an advancing and slowly declining wave of metamorphism. Part of the magma generated in depth may invade the superstructure, forming granite intrusions with contacts of various kinds, including those of Rosenbusch's Barr-Andlau type. For Termier, regional metamorphism and intrusions (at all levels) "are but two effects of the same cause." Although Termier's impressive synthesis was too imaginative to command serious attention, it nevertheless foreshadowed much of the progress that has since been made in this complex field of research. In particular, we find in it a revival of Fournet's early hint of what has recently come to be known as the advance of the 'migmatite front'.

The term *migmatite* was proposed by Sederholm for rocks which suggest by their appearance that they originated "by the mixture of older rocks and a later erupted granite magma". Along the shores of southern Finland and its fringing archipelagoes the wave swept rock surfaces display spectacular examples of all the phenomena associated with granitization. By means of a series of lavishly illustrated memoirs (1907-34), as well as by conducting several international excursions, Sederholm made these challenging exposures so generally familiar that the baleful influence of the Rosenbusch school was at last effectively countered. Sederholm did not maintain his first conviction that what had injected and permeated the older rocks was a primary granite magma, but he seems never to have abandoned altogether the idea—although he wavered at times—that such magma was the ultimate source of the invading materials. He envisaged an ultra-metamorphic process referred to as *anatexis*, involving injection, solution, refusion, assimilation and differentiation, whereby new magma was formed. The newly born magma, having the original granite magma and the country rocks as its parents, became available in its turn for further migmatization. Later, he ascribed less importance to granite magma, whether primary or secondary, and more to what he called *ichor*, a derivative magmatic solution highly charged with water and other volatiles, and thereby endowed with great penetrative power. The primary granite magma thus became only a grandparent of the second generation of *ichor*. The weakness of this conception lies in the implication that relatively small quantities of *ichor*, though derived by magmatic differentiation, had nevertheless sufficient energy and chemical activity to promote *anatexis* on a regional scale and so to make more magma and more *ichor* out of large quantities of country rock. Evidently if the immigrating materials are to be capable of effecting granitization or *anatexis* on the scale observed, they must differ fundamentally in properties and origin from the late stage exudations of a granite magma as ordinarily conceived. For this reason the neutral term *emanations*, which is free from genetic implications, is now coming increasingly into favour.

Wegmann, now Argand's successor at Neuchâtel, has greatly clarified our ideas by the results of his long and detailed field studies in Finland (1931, in collaboration with Kranck) and Greenland (1935 and 1938). Wegmann is especially interested in the mechanism of *stoffwanderung*, the migration of atoms involved in migmatization and granitization, and has made familiar the concept of an advancing migmatite front. He is also a pioneer in the attempt to unravel the complex relationships between orogenic movements and atomic migrations. He draws a graphic distinction between

(a) migration of elements through a framework of earlier rocks which remains stationary and so retains its former structures, despite extensive exchange of materials and recrystallization, and

(b) migration through a framework which is itself deformed by movements during or after the migmatization, in this case relative movement between the more mobile migmatized parts and the more rigid parts of the framework leads inevitably to intrusive contacts, and when, as must often have happened, the final crystallization of such mobile masses outlasts the movements, the ancestral structures are obliterated, except perhaps for a few schlieren and enclaves, and the eventual result is a more or less massive granite

The leading exponent of the subject in Sweden is Backlund, whose views have developed along essentially similar lines. He has particularly discussed the transformations of rocks such as limestone, quartzite and metabasite and has shown how selective and progressive metasomatism dispels the chemical difficulties that seemed insuperable to Callaway and Bonney and, more recently, to Harker and Niggli, the granitizing materials that are retained and fixed vary with the composition of the rocks that are being granitized. He has also stressed the important fact that granitization has been a normal accompaniment of orogenesis throughout geological time. Read gives an admirable account of these recent Fennoscandian developments, including a summary of the spirited debate between Backlund and von Eckermann (1937-38) on the genesis of the rapakivi granites.

The geochemical relationships involved in granitization can be briefly summarized in the formula: granite = pre-existing rock *plus* added material (*A*) introduced by and abstracted from the incoming emanations ($A + x$), *minus* displaced material (*B*) driven forward with the outgoing emanations ($B + x$). When successive stages of the transformation of pre-existing rock into granite can be seen in the field, it is possible (provided that there has been no significant volume change) to determine *A* and *B*. The most notable work along these lines has been that of Doris L. Reynolds. In the course of her investigation of the Newry complex, she has proved by chemical analyses of carefully correlated specimens that the minimum introductions (*A*) required for the granitization of the country rocks were sodium, calcium and silicon, while, after several intermediate exchanges that are traced in detail, the displaced materials (*B*) eventually carried forward consisted of aluminium, iron, magnesium, potassium, hydrogen, titanium, phosphorus and manganese. The latter, together with some remaining sodium, calcium and silicon, became fixed in adjacent bands of hornfels which were thereby basified and transformed into rocks chemically equivalent to certain varieties of quartz-diorite. From these results and other relevant evidence, Dr Reynolds concludes

(a) that the introduced material ($A + x$) cannot have been an ordinary magma, since *x* has left no recognizable traces in the rocks,

(b) that the basic material migrating from a region of granitization, besides enriching the surrounding aureole in biotite and other minerals, was probably also responsible for the 'igneous-looking' basic and ultrabasic rocks that overlie the granitic rocks of many plutonic complexes, and

(c) that before a given mass of country rock was actually granitized, it passed through a preliminary stage of basification.

From the nature of the case, little can be said about the ultimate source of the granite-making emanations. The granophytic contact zones and rheomorphic veins locally associated with dolerite sills and dykes in non-orogenic regions indicate that at least some basaltic magmas have been capable of providing a limited supply. In depth, basaltic magma may be a potential source of considerable importance. In orogenic regions, however, attempts to relate the emanations to the supposed magmas of associated basic rocks are weakened by the possibility, in some cases confirmed, that such rocks have themselves originated as complementary by-products of the granitization process. The major processions of emanations may conceivably be liberated from abyssal magmas by differentiation,

or squeezed out of the intensely sheared roots of growing mountain ranges, or they may have a source of some quite unsuspected kind. But our ignorance of the source of orogenic emanations in no way militates against the evidence of their passage through the rocks. The origin of basaltic magma remains equally uncertain, despite many optimistic suggestions to the contrary. Read quotes with approval Kennedy's recognition (1938) of two contrasted expressions of magmatic activity, distinguished respectively as

(a) *volcanic* associations, derived from a parental basaltic magma which originates by the remelting of the earth's basaltic layer, and

(b) *plutonic* associations, derived from a parental granodioritic magma which originates where tectonic thickening of the crust brings the 'granite' layer within the range of melting, the ascent of such magma is preceded by an advancing wave of granitization and migmatization.

Since 1938, more precise estimates have been made of the heat generated in rocks by radioactivity, and of the crustal heat flow that escapes at the surface in Britain, South Africa and eastern North America. The results imply that in these non-volcanic regions the normal granitic and basaltic layers fall short of the temperatures required for magma formation by several hundreds of degrees.¹ In the light of the evidence now available, we can do no more than speculate as to how basaltic magma comes into existence. Where the granitic layer is greatly thickened in the roots of mountain ranges, the temperature at the base might eventually rise to the point required to start selective fusion, but many millions of years would be required, and even then latent heat would have to be supplied. The suggested process therefore fails to account for the observed fact that granitic rocks began to be formed (at levels well within the range of subsequent denudation) while the orogenic movements were actively in progress. Thus the whole problem of magma generation, apart from the possibilities associated with the emanation hypothesis, is still as baffling as ever.

There remains for consideration the all-important space problem. How have large masses (batholiths) of granitic rocks come to occupy their present positions, and what has happened to the rocks that were previously there? The bodily intrusion of gigantic volumes of magma appears to be mechanically impossible, and, as Read puts it "The only solution is to suggest that in fact no large bodies of granitic magma were in existence. The large granite masses result from replacement, they are granitization products. Many of the small granites may of course also be of the same origin, but some of them may result from the consolidation of magma and some from the consolidation of magma. Thus, though there may be granites and granites, most of them are of one kind and all of them may likely be of one connected origin." With this conclusion I am in full agreement.

¹ Iddings, J. P., *Bull. Phil. Soc. Washington*, 12, 91 (1892).

² Read, H. H., "Meditations on Granite. Part I", *Proc. Geol. Assoc.*, 54, 64 (1943), Part II, *ibid.*, 55, 45 (1944).

³ Green, A. H., *Geol. Mag.*, 8, 428, 553 (1871).

⁴ Callaway, C., *Quart. J. Geol. Soc.*, 41, 221 (1885).

⁵ Rosenbusch, H., *Abh. Geol. Spezialkarte Elsass-Lothr.*, 1, 80 (1877).

⁶ Cole, G. A. J., *Quart. J. Geol. Soc.*, 71, 184 (1915).

⁷ Reynolds, D. L., *Proc. Roy. Irish Acad.*, 48 B, 231 (1943), *Quart. J. Geol. Soc.*, 93, 205 (1943).

⁸ Reynolds, D. L., *Quart. J. Geol. Soc.*, 97, 1 (1941). Walker, F., and Poldervaart, A., *Trans. Roy. Soc. S. Africa*, 29, 285 (1942).

⁹ Holmes, A., "Principles of Physical Geology", 480-483 (Edinburgh, 1944).

References already given by Read (see ref. 2) have not been repeated, the above are additional.

VARIATIONS IN THE COMPOSITION OF THE SEA IN WEST AFRICAN WATERS

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THERE appears to be very little published scientific information about the chemical characteristics and plankton content of the sea along the West African coast except for observations made by various scientific expeditions passing through these waters, and there appears to be no published data in English of continuous observations made over a prolonged period. An opportunity to make such observations presented itself in 1943 and 1944, arising out of a scheme by the Gold Coast Government to develop the local fishing industry, and an attempt has been made to obtain some information of the variations occurring throughout the year in the chemical composition and plankton content of the inshore waters of the Gold Coast Colony. As no suitable craft was available for going far out to sea, the samples were taken at a point about one and a half miles from the shore in a depth of eight fathoms of water off Accra, the capital of the Colony. Samples were taken each week (with one or two exceptions) from the beginning of June 1943 to the end of September 1944. One sample was taken for chemical examination and one for a rough examination of the quantity and general character of the plankton content, both samples were taken 5-6 feet below the surface. The temperature of the samples was taken at the time of sampling, and salinity, dissolved oxygen, and phosphate were estimated in the laboratory. These results are shown graphically in Figs 1 and 2.

From Fig. 1 it will be seen that during this period the variation in temperature exceeded 10° C. The highest temperature recorded was 29.4° C on May 13, 1944, and the lowest was 19° C on August 3, 1943. The lowest temperature recorded in 1944 was 19.8° C on August 18. The relatively sudden and wide variations in temperature which occur between June and October are presumably a causative factor in the seasonal nature of the fishing in the waters of the Colony. As might be expected, the figures for the salinity (‰) given in Fig. 1 do not, with one exception, show any wide variations, but there is a slight increase observed in August and September both in 1943 and 1944. The rather low salinities observed at the beginning of July 1943 occurred at times of heavy rain.

The one wide variation referred to above occurred at the end of January and the beginning of February 1944. At that time the salinity fell from 33.93 on January 25 to 30.05 on February 9, and then rose sharply again to 34.95 on February 22. This very sudden fall is difficult to explain. It occurred at a time when there was no rain in the Accra district or along the coast. At this time, however, there was a strong east-to-west current and the only reasonable assumption is that large volumes of water from the River Volta formed a surface current which flowed westward as far as Accra.

The figures for the dissolved oxygen shown in Fig. 2 are the amounts of oxygen expressed as the percentage saturation. The figures show a surprising consistency during the greater part of the year. From the middle of October 1943 to the middle of July 1944 the saturation never exceeded 100 per cent or fell below 94 per

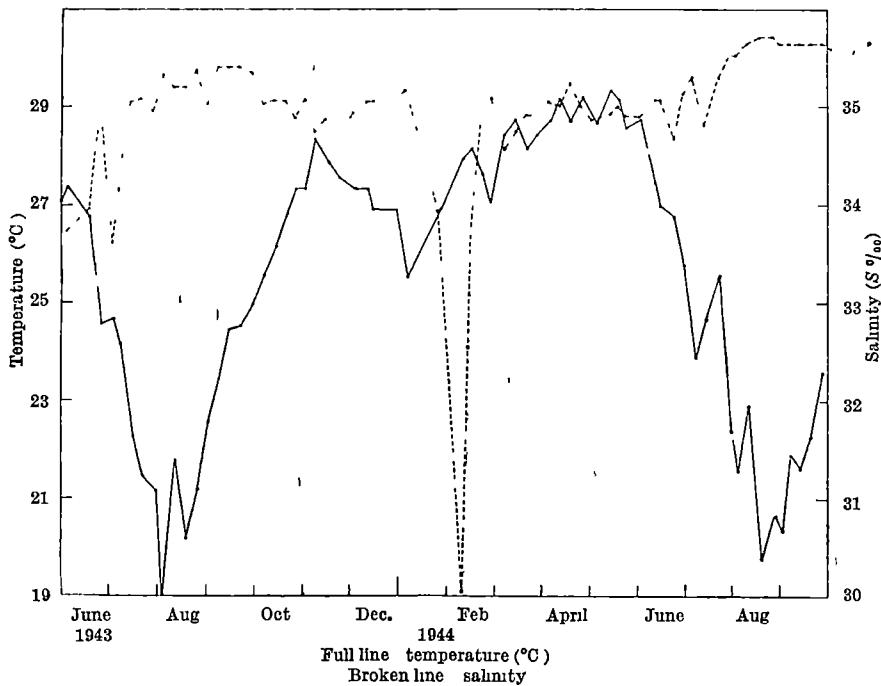


FIG 1

cent. The latter part of July, August and September brought wide variations both in 1943 and 1944.

The figures for the phosphate content given in Fig. 2 are the amounts of phosphate calculated as P_2O_5 per cubic metre. It will be observed that from the beginning of January to the end of March 1944 the amount of phosphate remained almost at zero, while July, August and September in both years saw moderately high values. The densities of the samples were determined at $80^\circ F.$ ($26.7^\circ C.$); the highest value was 1.0268 ($80^\circ/80^\circ$) on September 19 and 27, 1944, and the lowest was 1.0226 ($80^\circ/80^\circ$) on February 10, 1944.

As no trained marine biologist was available to undertake full examination of the plankton samples, their investigation was not so complete as could be desired, so only certain broad generalizations can be made. The vegetative plankton was found to consist of diatoms, chiefly *Chaetoceros* spp., *Coscinodiscus* spp., and *Rhizosolenia* spp., and dinoflagellates such as *Ceratium* spp. and *Dinophysis* sp. The animal plankton consisted almost entirely of crustaceans and *Sagitta* sp. The crustaceans were mostly various species of copepods, but numbers of the larval forms of larger crustaceans were found. Several species of echino-

derm larvæ were also taken in the tow-net, and on one or two occasions fish eggs were seen.

It was found that the character of the plankton samples changed considerably during the period under review. In June 1943 the samples were moderate in quantity and were composed chiefly of copepods and *Sagitta* sp. In July, August, and part of September 1943, the samples consisted almost entirely of diatoms, chains of *Chaetoceros* spp. being specially abundant. After the end of September, apart from a few *Coscinodiscus* spp., practically no diatoms were observed, the samples being composed of copepods and *Sagitta* sp. In January, February and March 1944 the samples were, generally, poor in quantity and were composed chiefly of copepods

and a few *Sagitta* sp. In April and May the quantity was generally larger and the samples were again composed of copepods and *Sagitta* sp. with a number of larval medusæ. At the beginning of June, diatoms began to appear in some quantity, although the catch was still composed chiefly of copepods. Later on in the month *Coscinodiscus* sp. and *Ceratium* spp. were also present, again with a large number of copepods. In July the quantity of the samples was considerably larger, and by the end of that month there were only a few copepods present and the bulk of the catch was *Coscinodiscus* sp. and chains of *Chaetoceros* spp. During this month, too, a considerable number of echino-

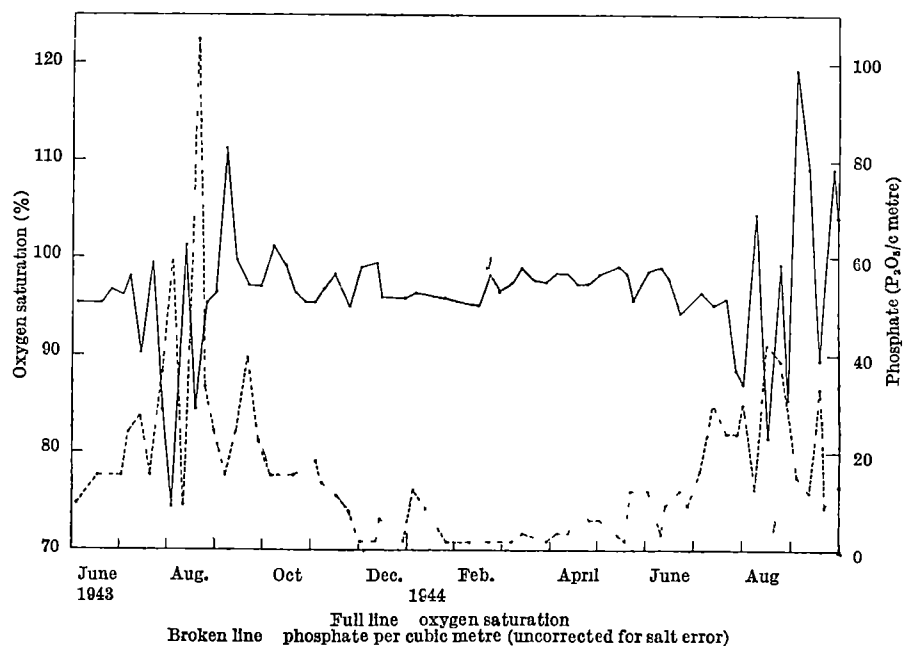


FIG 2

derm larvæ were observed. The character of the samples remained the same during the first part of August, but in addition some *Rhizosolenia* spp. (?) were observed. On August 16 a very unusual phenomenon was observed when taking the water sample. The sea was found to be a distinct chocolate-brown colour and very turbid. A sample was taken in a glass jar and the colour was seen to be due to vast numbers of a small greenish-brown organism just sufficiently large to be distinguished by the naked eye. Examination in the laboratory later on showed it to be a flagellated organism, which I was unable to identify. The plankton sample consisted almost entirely of masses of this organism. I do not know how far the coloration extended, but it was observed from aircraft for at least 70 miles along the coast. The phenomenon persisted for days, and when the next weekly sample was taken there were still masses of the organism in the plankton sample. During the first part of September *Coscinodiscus* sp and *Chaetoceros* spp composed the bulk of the catch, and later on *Noctiluca* sp (probably *N. scintillans*) predominated.

An examination of the data obtained from the samples appears to indicate that there is an influx of cold ocean water along the sea-board of the Colony during the months of July, August and September. This may be due to an upwelling of deep ocean water on to the continental shelf, or to cold ocean water from the South Atlantic Ocean finding its way into the current which flows for the greater part of the year from west to east along the sea-board of the Colony. It is probably not without significance that this influx of cold water, slightly more saline and richer in phosphate, coincides roughly with the main fishing season along the greater part of the coast of the Colony, when two species of *Sardinella*—*S. aurata* and *S. cameronensis*—are caught in large quantities.

It is hoped to continue and extend this work in the near future.

THE PUBLIC SCHOOLS OF BRITAIN

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THE public schools question has been somewhat in abeyance in recent months. Among the reasons for this is that the larger share of public attention in this province has been given to the Education Act, and the numerous administrative measures that are required to bring it into effective operation, and also that up to now the negotiations between the Ministry, on one hand, and the associations of governing bodies for boys' schools and girls' schools, the headmasters and headmistresses on the other, have been confined to scheme A of the Fleming Report, that is, the recommendations applying to what will be known in the future as direct-grant grammar schools. These negotiations are pretty well completed, and the revised regulations for direct-grant grammar schools have now been published. Discussions on scheme B, that is, those recommendations that affect mainly the independent boarding schools and day schools, are just beginning, and we may therefore expect a revival of public interest in the future of those schools.

The Fleming Committee is to be warmly congratu-

lated on producing a unanimous report on so difficult and controversial a question, and its whole discussion of the matter and its recommendations are clearly based on a wide and deep knowledge of conditions prevailing in the schools, and the concrete problems that have to be solved. Various proposals were put before them for the future regulation of the public schools. One extreme view was that they should be abolished altogether, their endowments taken over and their buildings dedicated to other educational purposes, hostels, residential courses in adult education and so forth. It is not likely that this view will be supported in any responsible quarter. Another suggestion was that the schools should be kept in operation, but should be handed over to the State to be run as part of the State educational service, boys and girls being allocated to them by public authority, and the schools being brought under full public control. The third proposal is that put forward by the Fleming Committee, namely, that the schools should remain independent, although open to inspection by the Ministry of Education and accepting to membership of their governing bodies public representatives up to not more than one third of the total number, and that they should reserve each year 25 per cent of their admissions for boys and girls who have previously been educated at primary schools, the expense, as calculated on a fee to be agreed upon for each school between the schools and the Ministry, to be met from public funds in so far as the parents themselves are unable to pay the full cost. It is around these recommendations that, no doubt, the coming negotiations will centre; and we may hope that in a few months some measure of agreement will be reached. It is made clear in the report that the co-operation of the schools is to be voluntary from their side and that no compulsion should be applied to them.

I submit that in the settlement of this great national question we should endeavour to free ourselves from political preconceptions and prejudice on both sides. History shows that politics is no friend to education, and that where political considerations and especially party considerations are allowed to come in from either end, the work of the schools suffers. I suggest that we should put all this on one side and base ourselves on two propositions. The first is contained in section 76 of the Education Act, 1944: "In the exercise and performance of all powers and duties conferred and imposed on them by this Act, the Minister and Local Education Authorities shall have regard to the general principle that, so far as is compatible with the provision of efficient instruction and training and the avoidance of unreasonable public expense, pupils are to be educated in accordance with the wishes of their parents". The second proposition is contained in the first recommendation on p. 100 of the Fleming Report: "that opportunities of education in the schools included in our terms of reference (i.e., roughly speaking, the public schools), and in any such other schools as may be approved for the purpose by the Ministry of Education, be made available to boys and girls capable of profiting thereby, irrespective of the income of their parents". No considerations other than these have really any bearing on the matter. If it is argued that ex-primary pupils should be taken into the schools at public expense in order to preserve the latter from extinction, that argument has no validity; if the schools cannot stand on their own feet, they had much better disappear. On the

other side, if it is argued that this infiltration, as it is called, of boys of one class into schools up to now reserved for boys of other classes, will have the effect of de-classing them, as it were, and detaching them from their former political and social allegiance, that also has no validity. Both are good examples of the wrong kind of approach. The only sensible and natural approach is surely this. Are there any parents who want their children to have boarding school education? If so, is it fair or right that they should be debarred from obtaining that education for their children because they cannot afford to pay the fees? Clearly the answer to this second question must be No. If the public schools have worked out an educational method and standard that parents believe to be valuable, ought access to those schools to be confined, as it is now, to exceptionally clever boys who win scholarships, and boys whose parents can afford to pay high fees? Clearly, again, the answer must be No. How, then, can we put matters right? I suggest by the adoption of a double-pronged policy, first that the State should provide boarding schools of its own, and power to do this is conferred upon the State by the Act, and secondly, that the existing boarding schools should take post side-by-side with these schools that soon, we hope, will be created, making their contribution under proper conditions, but preserving their independence. This policy will give rein to the incontestable right of parents to decide within reasonable limits how their children shall be educated, and it will at the same time enable the public schools to make their offer without forfeiting their independence.

It may be asserted, in reply. Why should the schools be allowed to retain their independence? On that the schools are unanimous and emphatic. It is not in the public interest that all schools of every kind should be controlled by the State, and this principle is conceded by Parliament in the Act. It is not the business of the State to control all education because it is the State, but rather to encourage good work wherever it is being done, and to supplement the existing provision where the latter cannot cover the ground. Spiritual and intellectual liberties of the highest significance for the welfare of Britain are involved in this, and it is probable that if, as a condition of participating in this or any other scheme, the schools are asked to surrender their independence, they will have nothing further to do with the matter. They would, I believe, be unanimous in welcoming, as they are now under the Act required to accept, inspection by the Ministry, and personally I can see no objection to the inclusion of public representatives in the proportion suggested on the governing bodies. There, however, external supervision should stop.

There are a large number of details that will have to be worked out and which cannot, owing to limitations of space, be set out in this article—for example, the age of entry, methods of selection, the preparatory stage, assessment of parental and other contributions, agreement upon the standard fee, etc. Two general considerations can be urged at this stage. First, the schools are at present crowded to overflowing, the public demand for them is great, and it may therefore take some time for them to work up to the full 25 per cent, if that recommendation should be accepted. Secondly, the report makes a fine offer to boys who have been previously educated at primary schools, and we may hope that nobody will seek to encroach upon or limit that offer to those

boys. But it remains true that very little is offered to parents in straitened circumstances, poor professional men, who have not sent their children to primary schools. In the interests of justice and equality it is clear that later on, if not now, measures will have to be taken to open the door to the children of these parents also.

During the last six years many pages have been written on the public schools, some of the authors being inspired by an irrational adulation of everything they do, and others by an equally irrational detestation of them and all their works. It may be hoped that during the months that are approaching all that sort of nonsense may be forgotten. The plain fact is that the schools have something to offer, and the plain question is, How can that be made use of in the interests of the nation as a whole? The latest volume on the public schools is called "The Public Schools and the Nation", by Dr A. B. Badger*. This is based on some careful research going back to the sixteenth century. The general tone of the book is critical, and no one who values the contribution made in the past, and to be made in the future, by the public schools will ever object to having their faults candidly pointed out. The general effect of the book is somewhat confusing, as it consists so largely of quotations from the opinions of other people, many of them expressed a number of years ago, and applying, therefore, to conditions which have long since ceased to exist in the schools. Readers will welcome Dr Badger's compilation and be grateful to him for his research, but the best of all guidance to future policy is to be found in personal, up-to-date, first-hand acquaintance with what the schools are and what they try to do.

* The Public Schools and the Nation. By Dr Alfred B. Badger. Pp. 160. (London: Robert Hale, Ltd., 1944.) 8s. 6d. net.

OBITUARIES

Sir Duncan Wilson, C.V.O., C.B.E.

SIR DUNCAN WILSON who, until his resignation in 1940 was chief inspector of factories, died suddenly on March 2 in his seventieth year. On leaving Eton he entered Magdalen College, Oxford, where he took his degree with first-class honours in natural science, and although his life-work has mainly been in administration, yet his scientific training proved a very valuable asset.

His official career falls roughly into three main periods. For fourteen years from 1904 he was a factory inspector, then came twelve years in which, as secretary, he organized the Industrial Fatigue (later Health) Research Board, after which he returned to his old department, first as deputy and then as chief inspector of factories.

Perhaps the mid-period gave Sir Duncan the greatest opportunity to use his scientific knowledge and to express his individuality. The Industrial Fatigue Research Board was a very small organization, formed at the dissolution of the Health of Munition Workers' Committee at the end of the War of 1914-18, to apply the principles of physiology and psychology to research into industrial problems. In his first annual report published in 1920 he wrote, "The scientific study of the laws governing the healthy employment of the human mind and body in industry was strangely late in its development in this country,

although it was in Great Britain that the industrial revolution had its first beginnings and industrial development was most rapid." In his next report he introduced the same theme, "Industries for the most part are not yet fully alive to the importance of the human factor in production and to the still greater part this is destined to play in the future." It is partly due to the early work of Sir Duncan that these words are less true now.

In his early organization each investigator was responsible for a particular industry, and the investigators concerned themselves principally with hours of labour and the general environmental conditions likely to cause undue fatigue. As time went on investigators developed individual interests and worked along more specialized lines. As an organizer, Sir Duncan interfered as little as possible with his staff, although he was always willing to help where help was needed, either in making arrangements with a particular firm, or advising on the form of a report, and no small part of the work of the Industrial Health Research Board has been made possible by his unobtrusive but valuable help. By 1930 there had been published fifty-six reports dealing with hours of labour, lighting, heating and ventilation, vocational guidance, boredom, accidents, time and motion study.

There was an entire absence of 'red tape' in his dealings with his staff, and all, however junior, could have access to him. He had a remarkable poise of personality which made him at home with people of all ages and social class. He could without conscious effort talk equally easily to a factory worker or a duchess, to an industrial magnate or a humble apprentice, and to go round a factory with him was invariably a valuable experience. He was unusually scrupulous in giving credit to researchers and in acknowledging their work. He had many interests outside his work and was an excellent amateur musician.

Sir Duncan's official retirement was in name only, for he carried on numerous activities after the outbreak of war, serving as chairman of the National Industrial Electric Lighting Service and of the Home Office Committee on Factory Lighting, a subject that had always been of great interest to him. He will, however, always be affectionately remembered by his colleagues for his humanity.

Prof. Paul Bertrand

SON of the distinguished palaeobotanist [Charles Eugène Bertrand (1851-1917), Paul Bertrand, the report of whose death has recently reached Great Britain, followed up his father's work on fossil plants, and became a leader in palaeobotanical research. He was professor of palaeobotany in Lille until 1938, when he was appointed to the chair of comparative anatomy for the study of fossil plants at Paris. He died in Paris after a short illness aggravated by privation and anxiety on February 24, 1944.

Most of Bertrand's published work falls within the period 1910-39. His most important contributions to the literature of his subject fall into two groups. His work on the Carboniferous floras of the French coal-measures has proved indispensable to students of Carboniferous stratigraphy in Europe and America. His recognition and demonstration of stages or zones in the succession of vegetation in the Carboniferous which could be recognized and defined by their floristic composition will remain, just as the corre-

sponding work by Kidston in Britain, a classic example of the application of palaeobotanical research to geology. Their work has led up to more recent work by Dr Dix in South Wales and by many workers in North America. As an accompaniment to this work he produced monographs of outstanding quality on the Pteridosperm genera *Alethopteris*, *Mariopteris* and *Neuropteris*.

The essence of all this research is contained in Bertrand's contributions to the *Comptes rendus* of the Congresses on Carboniferous Stratigraphy held in Heerlen in Holland in 1927 and 1935. On the botanical side, his work on Algæ (Botryococcaceæ) found as constituents of certain coals, and on the anatomy of Devonian and Carboniferous ferns, is of outstanding quality and importance. Here he ranks with Williamson, Scott, Kidston and Lang as an outstanding contributor to our knowledge of the anatomy of Devonian and Carboniferous plants.

Bertrand kept in touch with a wide circle of friends interested in palaeobotanical work, and, with Mme Bertrand, who survives him, regularly attended international meetings. Those who were privileged to know him will remember his quiet unassuming character, and his unfailing sympathy and interest in his friends' difficulties and problems. To know the Bertrands was to know what is best and most charming in the French character. His death causes an irreparable loss to many—especially to his younger colleagues, to whom he was unfailingly helpful.

JOHN WALTON

Dr Max Bergmann

DR MAX BERGMANN, the distinguished chemist, died in New York on November 7, 1944, at the age of fifty-eight. Dr Bergmann, who was born in Fuerth, Bavaria, studied chemistry in Munich and received his Ph.D. degree in the University of Berlin in 1911. He then entered the laboratory of Emil Fischer, where he worked until the latter's death in 1919. In 1921 Bergmann became director of the Kaiser Wilhelm Institute for Leather Research in Dresden, a position which he held until 1934. Shortly after Hitler came to power, Bergmann, being a Jew, resigned his post and accepted the position of an associate member of the Rockefeller Institute for Medical Research in New York. He was appointed a member of the Institute in 1937 and occupied this position at the time of his death.

Bergmann's work up to the time when he left Germany followed fairly closely both in subject-matter and in his way of approach that of his great master, Emil Fischer. It was concerned, almost exclusively, with the organic chemistry of amino-acids and carbohydrates. Fischer had discovered a new class of sugar derivatives, the glycals, but Bergmann proved that the structure assigned to them was not correct. He showed that these compounds were not aldehydes as Fischer had assumed, and also demonstrated the presence and position of a double bond and established the size of the ring. Another field of sugar chemistry in which Bergmann made notable contributions was that of chitin and glucosamine. His isolation of the disaccharide, chitobiose, was contemporary with that of Zechmeister.

The main interest of Bergmann was, however, in amino-acids. He extended greatly our knowledge of the azlactones, the highly reactive unsaturated anhydrides formed from amino-acids, his last paper, which appeared after his death, was devoted to this

subject. He was interested in most aspects of the organic chemistry of amino-acids, and it is difficult to single out particular contributions. His work was distinguished by a real elegance in conception and great skill in execution. Thus, his model experiments on the formation of creatine from arginine anticipated by many years more recent work on the occurrence of this reaction in the living animal. Bergmann's papers covered the problems of acyl migration, racemization, reactions of β -hydroxy- α -amino-acids, unsaturated peptides, and many others. His crowning achievement during that period was, however, his novel and important general method of peptide synthesis. The classical methods of Fischer permitted only the preparation of peptides made from simple amino-acids. Bergmann's new method made use of N-carbobenzoxy derivatives of amino-acids; the acyl substituent protected the amino-group during the condensation and could afterwards be easily removed by catalytic reduction. This new method made possible the synthesis of almost any desired peptide.

Bergmann's work during his second, American, period was turning away from pure classical, organic chemistry, and more concerned with the structure and biochemistry of proteins. He showed for the

first time that the pure crystalline, peptic and tryptic enzymes which had been prepared by Northrop and his school would act not only on proteins, as had been thought hitherto, but also on certain peptides. The work dealing with the substrate specificity of these enzymes was of much importance for our knowledge of enzymes and helped greatly towards a better understanding of the structure of proteins. Bergmann's work also extended to the proteinases of plants and those of animal tissues. Another field in which Bergmann made very important contributions was that of the analysis and isolation of amino-acids present in proteins; he discovered many specific precipitating agents for amino-acids and devised new and interesting methods of analysis. Together with Niemann he formulated the so-called 'frequency-law', which assumed that the different amino-acids in a protein molecule are present in certain restricted proportions. Although the exact quantitative relationships assumed may have to be modified, the emphasis on stoichiometric regularities has greatly stimulated analytical work and focused attention on the regularity of the internal architecture of protein molecules.

The loss of Dr. Bergmann will be felt by organic chemists and biochemists all over the world; he leaves a widow and two children. A. NEUBERGER

NEWS and VIEWS

Glass Technology at Sheffield:

Prof W. E. S. Turner, O.B.E., F.R.S.

THE announcement that Prof W. E. S. Turner is to retire from the chair of glass technology in the University of Sheffield, which he has held since 1920, comes as rather a shock. Prof Turner's name has become so closely associated with the application of scientific principles to glass manufacture that it is hard to visualize the industry without this association. In 1914, Prof Turner was responsible for the setting up of a Scientific Advisory Committee of the University of Sheffield to deal with technical problems arising in the local industries and, following on this work, was led to prepare a report on conditions in the glass industry. This report also made recommendations to the University Council, with the result that a Department of Glass Technology was set up in June 1915. This work was organized by Dr Turner, as he then was, and in 1920 the Council converted this Department to a chair of the University. From that date to the present, Prof Turner has made and established a name in connexion with the glass industry which will stand for all time.

Prof Turner founded the Society of Glass Technology in 1916, and has been editor of the Society's journal throughout its existence. He has been president of the Society on two occasions, 1922-24 and 1937-38, and has acted as secretary for three long periods. Prof Turner has also been instrumental in initiating international meetings between glass technologists in America, France, Belgium, Germany and Denmark, founding the International Congress on Glass, the first meeting of which was held in Milan in 1933. He was also responsible for instituting the Glass Convention, which brought together industrialists, administrators, commercial representatives and glass technologists. The teaching work of the Department under his guidance has been of such importance that many of his former students now occupy

important positions throughout the industry. His researches cover the whole range of glass technology and scientific research into glass and related problems. There can be few instances where one man has become so closely identified with an industry and where, in the lifetime of one man, and to a great extent due to his efforts, that industry has developed from one depending almost entirely on craftsmanship to the position where scientific control and mechanized processes have been so fully established.

Dr. Harry Moore

DR HARRY MOORE, who has been appointed by the Council of the University of Sheffield to succeed Prof Turner on his retirement, will bring with him to the task the benefit of a broad academic training and research experience, coupled with exceptionally wide and specialized technological knowledge. After a distinguished student career at the Royal College of Science during 1904-7, followed by a year as a demonstrator in the Physics Department of the College, he was, in 1908, appointed lecturer in physics at King's College, London, a post which he held until 1915. While there he published in the *Philosophical Magazine*, the *Proceedings of the Royal Society* and the *Proceedings of the Physical Society* papers on the influence of X-rays on various substances. Another group of papers on X-rays appeared between 1924 and 1928 in the *British Journal of Radiology*. During 1915-19 he was busy in connexion with Ministry of Munitions training schemes, finally being transferred to the Ministry of Labour Training Department as chief technical officer for south-west England. In 1919 he was appointed assistant director of research of the British Scientific Instrument Research Association under Sir Herbert Jackson, and when Sir Herbert retired in 1933, Dr Moore succeeded him. In 1937, Messrs Pilkington Brothers decided to build and equip extensive research laboratories and invited

Dr Moore to become the first director, a post which he still holds. He has served for some twenty-five years on committees of the British Standards Institution dealing with subjects related to instruments and to glasses for a variety of purposes, and since 1933 on the inter-departmental committee on optical glass set up by the three Service Departments. In April 1944 Dr Moore was elected to the presidency of the Society of Glass Technology, and has been nominated for a second year of office. Dr Moore, with his wise and genial personality and his wide experience of glass and its manifold applications, is an excellent choice for the variety of important activities centred in the work of the Department of Glass Technology of the University of Sheffield.

Fisheries Adviser at the Colonial Office

Mr. C. F. Hickling

THE Secretary of State for the Colonies has appointed Mr C. F. Hickling to be his fisheries adviser. This is the first time that the position has been filled on a permanent and full-time basis. Mr Hickling's predecessor, Dr E. S. Russell, having acted in a part-time capacity during a period of approximately two years. The possibilities for development and research in Colonial fisheries are very considerable, and the post of fisheries adviser is one of great opportunity. Mr Hickling, who will take up his duties immediately, will be assisted and supported in his task by the Colonial Fisheries Advisory Committee which was appointed in 1943.

After taking his degree at Cambridge, Mr Hickling engaged in postgraduate research at the Marine Biological Laboratory, Plymouth, and the Department of Oceanography, University of Liverpool, and in 1927 was appointed to the fishery research staff of the Ministry of Agriculture and Fisheries, in which he rose to the rank of senior naturalist. His work as a fishery investigator was of a high order; he published in several parts an excellent monograph on the hake and the hake fisheries, on which he became an acknowledged authority, together with many other papers on cognate subjects. His Buckland Lectures on the hake were published in 1934. During the War he has been acting as port fishery captain at Milford Haven with conspicuous success, and he has also found time to make a statistical study of the effects of the War upon the hake stocks, as yet unpublished.

Colonial Medical Research Committee

THE Secretary of State for the Colonies and the Medical Research Council have jointly created a Colonial Medical Research Committee to advise them on medical research for the benefit of Colonial territories. It is constituted as follows: Sir Edward Mellanby, secretary of the Medical Research Council (chairman), Colonel J. S. K. Boyd; Prof. P. A. Buxton, professor of entomology, London School of Hygiene and Tropical Medicine; Dr A. N. Drury, director of the Lister Institute of Preventive Medicine; Brigadier N. Hamilton Fairley; Dr W. H. Kauntze, chief medical adviser to the Secretary of State for the Colonies; Prof. B. G. Maegraith, professor of tropical medicine at the Liverpool School of Tropical Medicine; Dr B. S. Platt, director of the Human Nutrition Research Unit, Medical Research Council; and Major-General Sir John Taylor. The secretary of the Committee is Dr F. Hawking, of the National Institute for Medical Research, London, N.W.3.

Restoration of Pulkovo and Kiev Observatories

A FIVE-YEAR plan for rebuilding the famous observatory at Pulkovo on the outskirts of Leningrad is announced by the Academy of Sciences of the U.S.S.R. The main building is to be restored as it was originally, and such of the valuable equipment and instruments as were removed to safety before the Germans began the bombardment of the besieged city will be installed again. The Observatory was completely destroyed, and the cost of reinstatement is estimated at 137 million roubles. The world-renowned library could not be removed in time, and many irreplaceable books and manuscripts are lost to posterity. Adequate provision to restock the library includes the earmarking of 200,000 dollars for purchases abroad. Plans for work in the future suggest that the character of the institution is not to be changed: both fundamental astronomical work and astrophysical researches will be undertaken.

At Kiev, where less damage was done, work is so far advanced that this year's centenary of the foundation of the Observatory should see the whole of the staff back at work in a reconstructed establishment. With more warning of what was coming than their Pulkovo colleagues, the Ukrainian astronomers were able to transport most of the instrumental equipment to Sverdlovsk, 3,000 km. to the east, where they were given refuge during the occupation. On their return they found the observatory buildings empty, plundered and partly ruined by the fleeing Nazi army. Rebuilding has proceeded at such a speed, however, that new pavilions already house the 257-mm. refractor and the 120-mm. meridian circle, and regular observations and instruction have started again. Extensions on which work has already begun include a building for a proposed big modern refractor, an astrophysical laboratory and a deep basement for seismic work.

Technical Education in Scotland

SCOTLAND, a country that has long been education-conscious, is fully alive to the importance of technical education in modern social life, and the Interim Report on Technical Education recently issued by the Special Committee of the Advisory Council on Education in Scotland (H.M. Stationery Office, Edinburgh, 3d) advocates national planning on an extensive scale in order to bring training facilities within the reach of all. The core of the planning consists in the proposed establishment of a National Advisory Council for Technical Education, and four regional advisory councils (with a fifth for the Highlands, if necessary), all fully representative of industrial, commercial and educational interests, in order to survey both national and local requirements and to co-ordinate development schemes. The needs of part-time as well as full-time students have been considered in connexion with the organization of central institutions and local technical colleges, the former capable of dealing with work of the most advanced type and in some cases performing the functions of peak institutions for specialized subjects; technical instruction is also envisaged in the new colleges for compulsory further education of young persons and in voluntary day and evening classes where technical colleges cannot be established. It is realized that the new proposals will involve heavy financial commitments, and the National Council would therefore be required to make recommendations to the Secretary of State as to expenditure that is desirable. The proposals in the report are on a bold scale and well

calculated to produce a system of technical education to match the great literary and academic achievements of Scotland, which have perhaps in the past tended to obscure the activities of the technician, the artisan and the craftsman

A National Health Service

IN "Health Abounding", issued by the Social Credit Party, 2 Fitzroy Street, London, W 1, Dr A T Westlake describes the aims of the health service which is planned by the Social Credit Party. Dr Westlake begins with some telling remarks about our existing health services and about the Government's proposals for a national health service. Our existing health services are complex and confused, and we fail to apply the knowledge that we possess. Health is largely dependent on our ability to pay for it, in spite of numerous charities and the altruism of the medical profession. Our existing health organization has, Dr Westlake thinks, produced a magnificent service, but it contains fatal flaws, the most glaring of which is the making of a living out of ill-health. The Government's proposals for a national health scheme and the Beveridge proposals have brought matters to a head. All seem to be agreed that the future medical service will be a complete and comprehensive one covering everybody, but the problem is how best to create it. The Medical Practitioners' Union, the Socialist Medical Association and several other bodies advocate a State Medical Service, the British Medical Association seeks a compromise between the old system and the new proposals. A State medical service under present conditions can only mean, Dr Westlake argues, rigid control of both medical man and patient, with strict certification. The Government's White Paper is not a health scheme, but a medical and sickness service, it is not a free service, for it is to be paid for by taxation, rates and social insurance. The only basis upon which can we have a free State medical service which leaves the medical man a free agent is, Dr Westlake thinks, the Social Credit System.

The two main objects of this health service would be the health of the community organized into the cure, annihilation and prevention of disease and the promotion and maintenance of health, and the well-being and skill of all those who work in the health service. Curative work will for some time engage most of its attention, because of the gigantic proportions of the disease problem. No one is likely to object to Dr Westlake's excellent suggestions under this heading. He would treat the mind as well as the body, deal drastically with the patent medicine racket and create real health centres which would cater primarily for the healthy and only secondarily for the diseased, for whom curative centres would be provided. Dr Westlake here draws much on the experience of the Peckham Health Centre, which has provided valuable information. Prevention of disease depends on the abolition of poverty and on proper feeding, proper housing and elimination of industrial over-fatigue. These are the problems of social medicine, which is vitally important. Problems of immunization and health education are also discussed. In his discussion of health, Dr Westlake again refers to the work of the Peckham Health Centre. Not everyone will agree with the development of this section of the pamphlet, or with Dr Westlake's conception of a medical guild for the promotion of health and well-being. The General Medical Council exists for the protection, not of the

medical profession, but of the public. Dr Westlake would add to its functions the welfare and interests of the medical men also. Further sections of his pamphlet deal with administration, finance, hospitals and other details.

The Case for 'Planning'

THERE pamphlets issued by the Cheam Architectural Press (price 6d each) in "The Planning Bogies" series are too good to be popular. Those who dislike Prof H J Laski are unlikely to be pleased with the way in which in "Will Planning Restrict Freedom?" he disposes of the bogie of bureaucracy, and the more ardent planners may be restive under his trenchant delineation of the conditions which planning machinery must serve in a democracy—his insistence on the participation of the ordinary citizen is, moreover, reflected in the other pamphlets. Mr E S Watkins in "How Will Planning Affect Land Ownership?" deals with nationalization, but the pamphlet also gives an admirably lucid explanation of the existing land ownership system in Britain and of proposals for reform as contained in the Uthwatt Report and elsewhere. The broad objectives of land control—to ensure both the best economic and the best social use of our land and resources—are well stated, and also the basic requirements of control, they lead to concrete suggestions as to the composition and areas of planning authorities and amendments to the Town and Country Planning Act, which would transfer the responsibility for planning from the existing local government authorities to *ad hoc* area planning committees.

Mr E F Schumacher, in examining the question "What Will Planning Mean in Terms of Money?", discusses first the case for physical planning, he believes that, when the social costs of unplanned development are taken into account, the question becomes rather whether we can afford to do without planning. Emphasizing the growing divergence between private and social costs, he examines the case for housing in further detail, and argues that physical planning is the pre-condition for the successful pursuit of a housing programme such as the Government is preparing to inaugurate. Without it a steady effective demand cannot be maintained, the programme will be wasteful and head for an early collapse.

New Electron Microscope for Canada

THE National Research Council of Canada announces the installation of the latest type of electron microscope in its Ottawa laboratories. This instrument and one developed in the Physics Department, of the University of Toronto are the first electron microscopes to be used in Canada. A third microscope will be installed shortly at McGill University in Montreal. Plans to purchase this modern research instrument were made a year ago when the Council sent two physicists to the United States to study the available types. After the new RCA Universal model was selected, priority application was made to the United States War Production Board, which scheduled delivery for January 1945. The Division of Physics and Electrical Engineering has provided laboratory space for the microscope and assigned a physicist in the Radiology Section to take charge of it. It is hoped to make this new electron microscope as widely available in Canada as possible to all Government laboratories and to those industries having suitable problems.

Recent Earthquakes Recorded in the British Isles

THE earthquake widely noted in Britain on December 30, 1944, was recorded at Kew. From a preliminary reading of the record, it appears to have registered first at 00h 36m 14s GMT from an epicentral distance of 300 km. This would make the initial time of the shock 00h 35m 35s GMT. Four strong shocks were recorded at Kew between January 9 and February 13, 1945. The strongest was on February 10, when an earthquake beginning in the region of Japan attained a ground amplitude of 145μ at Kew. Mr E W Pollard recorded two strong shocks on January 12 and 18, and earthquakes or tremors on February 10, 13, 17, 18 and 26 at his observatory at Binstead, Isle of Wight. The United States Coast and Geodetic Survey determined the epicentre of the earthquake of January 1, 1945, to have been near Baffin Bay.

War and Infectious Diseases

AT a Chadwick Lecture on this subject delivered on February 20 at the Royal Society of Tropical Medicine and Hygiene, Dr J D Rolleston discussed the various acute infectious diseases in relation to war in the following alphabetical order: cerebrospinal fever, diphtheria, dysentery, enteric fever, infectious hepatitis, malaria, measles, mumps, scarlet fever, small-pox, streptococcal infections, typhus fever and war wounds. Chronic infections, particularly tuberculosis and syphilis, were not considered. Comparative novelties mentioned in the lecture included diphtheria of the skin, infective hepatitis, the striking decline in the incidence and mortality of enteric fever, and the introduction of new specific remedies, of which the most valuable were penicillin for war wounds, sulphaguanidine for dysentery and atabrin for malaria.

Poliomyelitis Epidemic in America

ACCORDING to Mr B O Connon, president of the National Foundation for Infantile Paralysis (*J Roy Inst Pub Health and Hyg*, Feb), the 1944 epidemic in the United States has been the second worst in the recorded history of the disease. The seven States most severely menaced are New York, North Carolina, Pennsylvania, New Jersey, Virginia, Ohio and Kentucky. The peak of the epidemic was reached in the week ending September 2, when 1,683 cases were reported.

Colonial Office Appointments

THE following appointments have recently been made in the Colonial Services: D P Pielou, to be entomologist, Northern Rhodesia; E G A Benson, agricultural superintendent, British Guiana, to be agricultural officer, Trinidad; J D Brown, senior agricultural officer, Nigeria, to be principal agricultural officer, Nigeria; M A G Hanschell, agricultural superintendent, British Guiana, to be agricultural officer, Sierra Leone; L P Henderson, agricultural officer, Nigeria, to be senior agricultural officer, Nigeria; A Pitcairn, assistant director of agriculture, Cyprus, to be senior agricultural officer (supernumerary), Tanganyika; F E V Smith, principal assistant secretary (Development Branch), Nigeria, to be development secretary, Nigeria; C B Taylor, agricultural officer, Nigeria, to be senior agricultural officer, Nigeria; D H Urquhart, assistant director of agriculture, Nigeria, to be director

of agriculture, Gold Coast; R G M Willan, assistant conservator of forests, Cyprus, to be assistant conservator of forests, Nyasaland; E D Fort, surveyor, Gold Coast, to be senior surveyor, Gold Coast.

Prizes for Scientific Instrument Manufacture

MR W BOWEN, governing director of the Bowen Instrument Co, Ltd, Cables and Plastics, Ltd, and Bowen Research, has presented to the Scientific Instrument Manufacturers' Association a substantial capital sum, the income of which he wishes to be devoted towards the encouragement and development of invention, design, research, processes and manufacturing technique in the scientific instrument manufacturing industry. The Council of the Association has accordingly drawn up a deed of trust under which the income from the fund is to be devoted each year to prizes to be awarded to the employees of members submitting papers fulfilling the objects of the trust. For the current year the Council has decided to award five prizes to the value of £25 each for (a) a new invention, (b) an improvement of design, (c) an improvement in manufacturing technique, (d) a new development or new process arising from research, and a list of topics defining the subjects or instruments admissible has been drawn up. Candidates should furnish a short description of one of the above subjects not exceeding 3,000 words with relevant sketches or diagrams, and they must be employees of members of the Association. All papers must be submitted to the secretaries of the Association, Messrs Bunder, Hamlyn and Co, River Plate House, 12-13 South Place, London, EC 2, not later than December 31, 1945.

Announcements

DR N FEATHER, lecturer in physics in the University of Cambridge, has been appointed professor of natural philosophy in the University of Edinburgh, in succession to the late Prof C G. Barkla.

DR L C BURRILL has been appointed professor of naval architecture at King's College, Newcastle-upon-Tyne, as from October 1, 1945. Dr Burrill is thirty-nine years of age. He has had a wide practical experience of naval architecture with Messrs Swan Hunter and Wigham Richardson, Ltd (1929-34), and the Manganese Bronze and Brass Co, Ltd, where he has held the position of naval architect since 1936. In addition to extensive research resulting in the recent award of the degrees of M Sc and Ph D in naval architecture, he also lectured at the Rutherford Technical College, Newcastle-upon-Tyne, for three years.

Messrs Power Jets (Research and Development), Ltd, Whetstone, Leicester, have formed a Trade Catalogue Section in their Whetstone Library. Firms interested and associated in the production of machine tools, factory plant and equipment, physical and chemical laboratory equipment, electrical equipment, switch gear, motors, transformers, generators, etc., hydraulic pumps, air compressors, etc., who are willing to deposit a copy of their latest catalogues with Messrs Power Jets (Research and Development), Ltd, are asked to send copies of their publications to the Librarian, Power Jets (Research and Development), Ltd, Whetstone, Leicester, for inclusion in the Library.

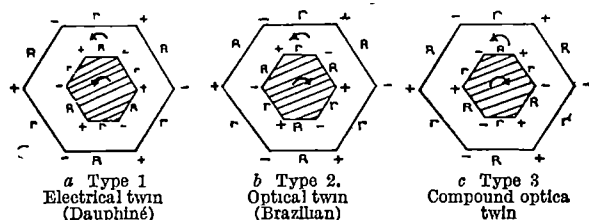
LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications.

Terminology of Interpenetrating Twins in α -Quartz

AMONG those concerned with piezo-electric applications, it would appear that there is some confusion in the terminology for describing the interpenetrating twins which occur in α -quartz. For piezo-electric purposes, the highest quality Brazilian quartz is normally used, and there are three types of twinning of importance. These are, type 1, the rotational (Dauphiné) twin, type 2, the reflexion (Brazilian) twin, and type 3, a compound twin which can be regarded as a combination of types 1 and 2. Quartz technologists have their own terms for these twins, thus the first type is termed an 'electrical twin', the other two types are broadly spoken of as 'optical twins', but their more exact descriptions are not well established.

While it has been customary to term the second type an optical twin and the third type a combined electrical and optical twin (compound optical twin), this nomenclature is sometimes, and it is thought incorrectly, reversed.



The accompanying illustrations show sections perpendicular to the trigonal (optic) axis in quartz crystals twinned respectively in each of the three ways. For clarity the sections are drawn as regular hexagons, the parent crystal completely enclosing the twinned areas (shaded hexagons). In practice, the twinning is usually irregular and often extends inwards from the outside of the crystal, but the diagrams retain the fundamental relationships, such as crystallographic orientation and electrical polarity. In each instance, optical activity is indicated by an arrow curled in the sense of rotation of plane-polarized light looking along the optic axis towards the source. Also, the parent crystal is chosen to be left-handed according to this convention. In denoting electrical polarity, the untwinned and twinned portions of the crystal are considered separately. Then the polarities marked at the vertices of the hexagons show the signs of the piezo-electric charges which would be produced at the prism edges on compression of the corresponding diameter. Finally, the lettering indicates the type of rhombohedral face occurring above each prism face, as represented by the sides of the hexagons. *R* and *r* indicate what are termed mineralogically the positive and negative rhombohedral faces respectively.

In all three types of twin, the optic axis is the twin axis. The rotational twin (Type 1) corresponds to a rotation of 60° about the optic axis without change of optical sense. Positive and negative rhombohedra are thus brought into coincidence, that is, *r*-faces of the twinned portion become parallel to

R-faces of the parent crystal and vice versa. Also the sense of polarity of the twinned material is reversed with respect to that of the parent crystal. That is, the crystal as a whole is elastically and electrically inhomogeneous, but optically it is homogeneous. It is therefore appropriate to term this an electrical twin, and obviously this type of twin cannot be detected by direct optical means.

The reflexion twin (Type 2) corresponds to a reversal in the sense of the screw about the optic axis, without any rotation about this axis. That is, the sense of optical activity of the twinned portion is reversed whereas its orientation remains uniform with the rest of the crystal. The crystal is elastically homogeneous but optically inhomogeneous, and because of the reversal of the screw axis the twinned portion is of opposite electrical polarity. It should be noted that the cause of this reversed polarity is unrelated to electrical twinning as described above. This type of twin should be regarded as a purely optical twin, but confusion can arise because of the accompanying electrical inhomogeneity. If the crystal is described as a combined electrical and optical twin it might be thought that the reference was to a combined Dauphiné and Brazilian twin, which is incorrect.

The other twin (Type 3) corresponds to a reversal in the sense of the screw axis together with a rotation through 60° about this axis. That is, it can be regarded as a combination of the first two types of twin. The crystal is both elastically and optically inhomogeneous, but there is no reversal in the electrical polarity of the twinned portion. This type of compound twin is comparatively rare.

It would seem, therefore, that the following terminology should be adopted among those using quartz for piezo-electric purposes. Type 1 should continue to be termed 'electrical twinning'. Type 2 should be termed 'optical twinning', or 'simple optical twinning' where there is any risk of ambiguity. Finally, type 3 should be termed 'compound optical twinning'.

L. A. THOMAS

Research Laboratories,
General Electric Co. Ltd.,
Wembley Feb. 5.

Mechanism of the Oxidation of Coal

It is well understood that the mechanisms of the oxidation of oils¹, the curing of rubber², the polymerization of unsaturated compounds³, the overall combustion of higher hydrocarbons⁴, as well as of certain biological processes⁵, involve the formation of peroxidic bodies sometimes initiating chain reactions. Little attention has been directed hitherto to the possible role of such bodies in processes concerned with the solid phase.

The importance of the spontaneous oxidation of coal needs no emphasis, apart from fire risk, weathered coals may lose up to 15 per cent in calorific value⁶, and the coking property of gas-making coals may be destroyed. There have been occasional suggestions in the literature that the initial oxidation may involve peroxidation⁷, but so far as we are aware, no serious attempt has been made to investigate the matter. Recently we have adapted Yule and Wilson's method of estimating peroxygen⁸, for the purpose of studying the behaviour of typical coals during oxidation, and the results have proved informative.

At room temperature, finely divided fresh coal accumulates peroxygen on exposure to the atmosphere, a maximum content being reached after several weeks; this may amount to 60×10^{-6} gm. per gm. of coal. At higher temperatures its rate of formation progressively increases, but above 80°C . the maximum ultimate content falls owing to decreasing stability. Experiments with some six coals have shown known ease of weathering to fall into line with degree of peroxidation.

If previously exposed coal be heated above 80°C . in an inert atmosphere, the breakdown of peroxygen can readily be followed. Further, whereas a suitable finely ground fresh coal will ignite spontaneously in oxygen if rapidly raised to a temperature of c. 135°C ., a similar specimen, if subjected to such a preheat treatment, will not ignite.

It is well known that the attainment of a temperature of 85°C . in stored coal is dangerous; above it, oxidation becomes autogenous and there is serious risk of fire⁹. In our experience the oxidation mechanism changes at about this temperature. Below it, a relatively high concentration of peroxygen is formed, little oxygen entering into the coal substance and carbon monoxide preponderating in the gaseous products. Above it, the peroxygen breaks down rapidly, oxygen enters the coal substance and carbon dioxide preponderates in the gaseous products.

We are of the opinion that the peroxide material on decomposition opens the structure for further oxygen attack; and its rate of formation and subsequent breakdown may be taken as an index of the speed of overall oxidation in the temperature range in question. How far peroxidation is a surface effect, and how far an attack on specific chemical structures are matters for further investigation; the method has shown that certain carbons have the ability to form peroxygen¹⁰.

This investigation has been carried out during the tenure by one of us (R. E. J.) of the Institution of Gas Engineers Research Fellowship.

R. E. JONES.

D. T. A. TOWNEND.

Dept. of Coal Gas and Fuel Industries,
University of Leeds. Feb. 12.

¹ Denison, *Ind. Eng. Chem.*, **36**, 477 (1944).

² Farmer, *J. Chem. Soc.*, 125 (1943).

³ Moureu and Dufrasse, *Bull. Soc. Ind. Nat.*, 107 (1934).

⁴ For example, Egerton and collaborators, *Phil. Trans. Roy. Soc.*, **A**, 234, 433 (1935).

⁵ Rieche, *Z. ang. Chem.*, **45**, 441 (1932).

⁶ Beagle, *Ind. Eng. Chem.*, **17**, 123 (1925).

⁷ Porter and Ralston, *Bur. Mines. Tech. Paper*, 65 (1914). Bunte and Brückner, *Z. ang. Chem.*, **47**, 84 (1934).

⁸ Yule and Wilson, *Ind. Eng. Chem.*, **23**, 1254 (1931).

⁹ Rose and Sebastian, *Fuel*, **11**, 284 (1932). Oreschko, *Bull. Acad. Sci. U.R.S.S.*, Pt. 7, 52 (1943). "The Efficient Use of Fuel", 41 (H.M. Stationery Office, 1944).

¹⁰ Lamb and Elder, *J. Amer. Chem. Soc.*, **53**, 157 (1931). King, *J. Chem. Soc.*, 842 (1933).

Phase-retarding Areas

THE phase retardation provided by evaporated fluoride films on transparent plates, suggested by E. H. Linfoot¹ as being of possible use in phase contrast microscopy, finds an important application in interferometry, where the phase-retarding areas have to be of much larger dimensions than are involved in phase contrast microscopy or applications of the Zernike test. It forms the basis of a method, developed here some time ago, of distinguishing between under- and over-correction of the aberrations corresponding to

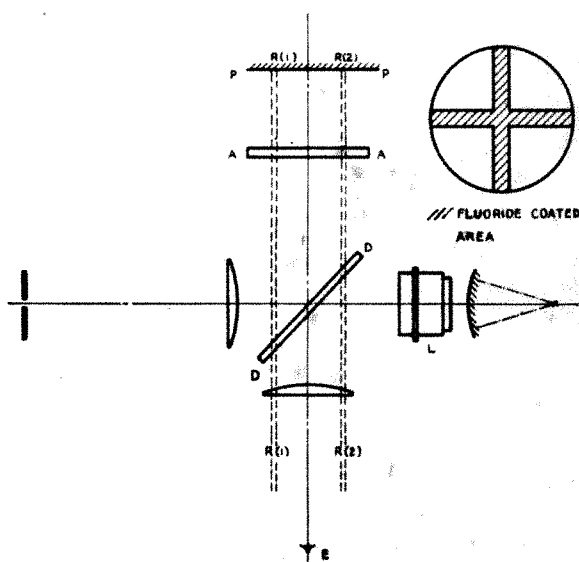


Fig. 1.

the pattern of interference fringes observed while using the Hilger lens-testing interferometer.

Where visual use alone is of importance, the sign of the wave deformation impressed by the lens *L* in Fig. 1, relative to the plane wave reflected by *PP*, is readily obtained by exerting a gentle pull on the cables *R1* or *R2* controlling the to-and-fro movement of *PP*. When a photographic record of the performance of a model lens is required, this method is not available. We have therefore inserted at *AA*, as shown, a plane parallel plate bearing on one face a cruciform fluoride-coated area (see inset diagram). A suitable film thickness may be deposited by continuing the evaporation for a little more than twice as long as the normal evaporating time for producing a non-reflecting film. Due to the double passage of the light through the plate *AA*, such a fluoride film impresses upon the light passing through it a phase retardation of approximately $\lambda/4$ relative to light transmitted by the uncoated areas. As a result, the fringes seen are displaced by quarter of a fringe where they are crossed by the fluoride-bearing area, the displacement being in an inwards direction when the wave-front distorted by passage through the lens *L* is concave towards the eye at *E*, and in an outwards direction when the wave-front is convex towards the eye. Typical examples of interferograms are shown in Fig. 2, at (a) without the fluoride-coated plate, and (b) with the plate in position. The inward dis-

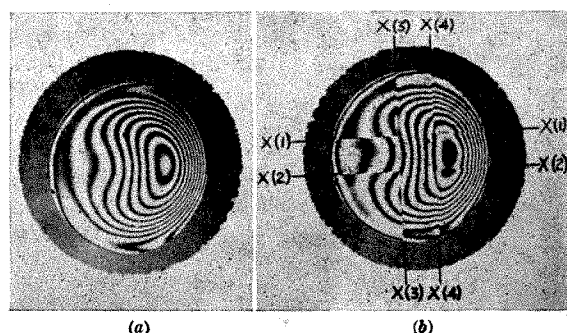


Fig. 2.

placement of the fringes along the lines XX in 2(b) shows that the wave surface distorted by the lens L in this case is concave towards the eye at E .

Other arrangements are possible. For example, the film may be formed on a surface of the diagonal DD ; or in place of a cruciform coated area on one side of a plate, there may be used what is, in some respects, a preferable arrangement, namely, a clear area on each side of a plate carrying a normal amount of fluoride to produce a non-reflecting film, the two areas being similarly situated, so that light travelling in the arm of the interferometer including PP either traverses four thicknesses of film or none.

ARTHUR COX.

Research Department,
Taylor, Taylor and Hobson, Ltd.,
Leicester.
Jan. 30.

¹ Linfcoot, E. H., *Nature*, **155**, 76 (1945).

Rotational Analysis of the S_2 Band Spectrum

THE most complete vibrational analysis of the S_2 bands lying between $\lambda 2300$ and 6200 Å. has been given by Fowler and Vaidya¹. They agree with the perturbations of the $\Delta G'$ values found by Christy and Naudé².

This irregular behaviour of the $\Delta G'$ values of the S_2 molecule no doubt complicates the rotational structure of the bands considerably. Olsson³, however, seems to have succeeded in obtaining a satisfactory rotational analysis of the (3,2), (2,2), (3,3), (2,3), (1,3), (2,4) and (1,4) S_2 bands in absorption. It appeared to be of great value to verify Olsson's analysis by analysing the S_2 band spectrum obtained in emission. Seeing that it is possible to carry out the analysis with greater accuracy in emission, it was hoped to obtain more accurate information about the observed perturbations of the $\Delta G'$ values.

The S_2 bands lying between $\lambda 440$ and 4950 Å. have been photographed in the fourth order, and the bands lying between 4950 and 6200 Å. have been photographed in the third order of the 21-ft. Gale concave grating mounted according to Paschen in this Institute. The dispersion obtained amounted to about 0.6 Å. per mm. in the fourth order and to about 0.8 Å. per mm. in the third order. The positive column of an inverted II-tube constructed of 'Pyrex' glass and fitted with large cylindrical electrodes was used as light source. The sulphur was purified by slowly redistilling flowers of sulphur four times *in vacuo* from one 'Pyrex' vessel to the next by means of an electrical oven. The final 'Pyrex' recipient was sealed on to the capillary tube joining the electrodes of the II-tube during the distillation. The light from the capillary tube passed through a quartz tube with sealed-in clear window. The quartz tube was sealed on to the 'Pyrex' tube with white sealing wax. The window was kept clear by constantly heating it with a small gas flame. The 'Pyrex' tube was first evacuated to a pressure of about 10^{-5} mm. of mercury. The sulphur in the side tube was heated to about 170° C. The discharge between the electrodes was maintained in pure sulphur vapour by a 5-kVA. 220–12,000-volt step-up transformer. Thus an S_2 light source was obtained which was very intense in the capillary tube and which could be photographed end-on through the quartz window.

The (1,14) band with its head at 4433.6 Å.; (1,15), at 4565.2 Å.; (2,16), at 4610.2 Å.; (2,17), at 4747.6 Å.; (3,17), at 4651.3 Å.; (3,18), at 4790.8 Å.; and the (3,19), at 4937.2 Å. were photographed in the fourth order of the grating. The iron arc was used to supply the comparison spectrum. Using Eastman 33 plates, the exposure time required for all the bands except the (3,19) band was about two hours with a current of 18 amp. passing through the primary of the transformer. The (3,19) band required an exposure time of about twenty hours on Eastman IIIF plates.

The plates were measured correct to 0.001 mm. on a large Abbé-type comparator built in our Institute. The wave-lengths of the iron lines were obtained from Harrison's M.I.T. Wave-length Tables. The wave-lengths of the sulphur band lines were converted to wave-numbers *in vacuo* by using Kayser's "Tabelle der Schwingungszahlen".

Practically all the stronger lines of favourably situated bands, such as the (3,17) and (3,18) bands, could be accounted for by six branches. These six branches could be identified as R_1 , R_2 , R_3 , P_1 , P_2 and P_3 branches corresponding to a $^3\Sigma_u^- \rightarrow ^3\Sigma_g^-$ transition.

The $\Delta_2 F_1$ values of the $v' = 1, 2$ and 3 vibrational states were found to agree within experimental error with those computed from the wave-numbers of the branches observed by Olsson. From the agreement of the $\Delta_2 F_1$ values obtained in the present analysis in emission, it became clear that an accuracy up to one in two million had been reached, and that the accuracy was greater than that obtained by Olsson in absorption.

The values of B'_v and B''_v could be obtained graphically from the $\Delta_2 F''_2$ and $\Delta_2 F''_2$ quantities of the various states and thus B_e and r_e could be found. These values are given in the accompanying table.

v'	B'_v	B''_v	
27	0.2502 ± 0.0001 (Naudé)		
25	0.2539	"	
24	0.2556	"	
23	0.2568	"	
22	0.2589	"	
19	0.2635	"	B''_v (extrapolated) = 0.2947 cm. ⁻¹ .
18	0.2651	"	
17	0.2666 ± 0.0002	"	$B''_v = 0.2955$ cm. ⁻¹ .
16	0.2681 ± 0.0001	"	$r'_e = 1.893 \times 10^{-8}$ cm.
15	0.2700	"	
14	0.2716	"	$\alpha'' = 0.0016$ cm. ⁻¹ .
8	0.2819 ± 0.0002 (Wilson)		
7	0.2834	"	$D'' = -19.6 \times 10^{-8}$ cm. ⁻¹ .
4	0.2885	" (Olsson)	
3	0.2896	"	
2	0.2915 ± 0.0001	"	
v'	B'_v	B''_v	
7	0.2085 ± 0.0002 (Naudé)		
6	0.2102 ± 0.0001	"	$B'_v = 0.2219$ cm. ⁻¹ .
5	0.2102	"	
4	0.2150	"	$r'_e = 2.184 \times 10^{-8}$ cm.
3	0.2129	"	
	0.2136 (Olsson replotted)	"	$\alpha' = 0.0018$ cm. ⁻¹ .
2	0.2175 ± 0.001 (Naudé)		
	0.2177 (Olsson replotted)	"	$D' = -23.1 \times 10^{-8}$ cm. ⁻¹ .
1	0.2205 ± 0.0001 (Naudé)		
	0.2200 (Olsson replotted)	"	
0	0.221 ± 0.001 (Wilson)		

The B'_v and B''_v values obtained from the partial analyses of the (4,19) band with head at $\lambda 4842.2$; (4,22), at 5309.9 ; (5,22) at 5193.7 ; (5,23), at 5359.7 ; (6,23), at 5249.8 ; (6,24), at 5418.7 ; (6,25), at 5596.1 ; (7,25), at 5472.5 ; and (7,27), at 5840.2 Å. are also included in the table. The B''_v , B''_v , and B'_v values included in the table were obtained from an unpublished M.A. thesis (1941) of Mr. F. J. Wilson of the University of Saskatchewan, Saskatoon, an extract of which was kindly sent to me by Prof. G. Herzberg. The B''_v , B''_v , and B'_v given in the table

were obtained by Olsson. The values of B'_3 , B'_2 and B'_1 given by Olsson differed from those found by me, although the $\Delta_2 F'_2$ values were practically the same. Olsson's $\Delta_2 F'_2$ values for the $v' = 3, 2$ and 1 vibrational levels were, therefore, replotted and are also given in the table.

A complete report on the results obtained so far will be published in the *South African Journal of Science*. The perturbations observed in the $v' = 2, 4, 6, 7$ and 8 levels are being investigated further.

S. M. NAUDÉ.

Merensky Institute for Physics,
University of Stellenbosch,
Stellenbosch. Dec. 8.

¹ *Proc. Roy. Soc., A*, 132, 310 (1931).

² *Phys. Rev.*, 37, 903 (1931).

³ *Z. Phys.*, 100, 656 (1936).

Open Packing of Spheres

MR. S. E. ACKERMANN's axiom¹ that spherical lumps of coal of equal size have the same bulk density irrespective of the actual size is surely applicable to any symmetrical arrangement of such spheres, including the closest packing. The arrangement of spheres which he uses in his first calculation is symmetrical and satisfies the axiom, but is not a stable arrangement which would be attained by pouring the spheres into a box. His statement that the closest packing gives an increase in density as the size of sphere is decreased appears to be derived from an incorrect conception of what constitutes the closest packing. This is, of course, the arrangement in which each sphere touches twelve others (not eight), lines joining the centres forming a system of regular tetrahedra, and is the stable one which is taken up automatically.

Using Mr. Ackermann's nomenclature, the number of spheres per cubic foot is $n^3\sqrt{2}$, and the bulk density

becomes $\frac{\pi}{6}\sqrt{2}$, or 0.739. This relation holds so long

as the spheres are small compared with the dimensions of the container. A smaller density will obviously result if there are spaces nearly but not quite large enough to accommodate further spheres, and which are of the same order of dimensions as the container. Such a condition applies to the later examples quoted by Mr. Ackermann, but the results obtained even with the true optimum packing are obviously specific to a 10-in. cube and are not, therefore, of general application.

S. G. FOORD.

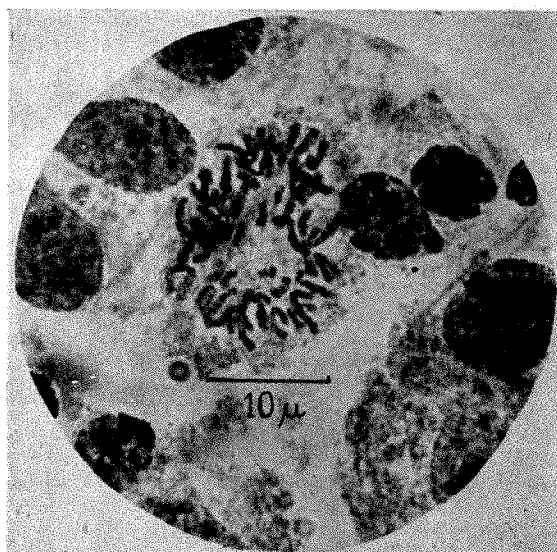
17 Balcaskie Road,
Eltham, S.E.9.

¹ *Nature*, 155, 82 (1945).

Human Chromosomes

In the last few years chromosome studies have made great progress both in theory and in methods. These methods are, however, little known outside genetical laboratories.

The application to human chromosome studies of the techniques developed in cytological laboratories has been a particularly useful complement to the histology of bone marrow, and its relations to normal and pathological haemopoiesis. The results of this kind of work in haematology have been partly published^{1,2}, and the detailed morphology of human chromosomes is at present under investigation.



The accompanying photomicrograph from a slide made by the acetocarmine squash method³ shows a metaphase plate in a mononucleated bone marrow cell obtained by sternal puncture.

So far as I am aware, no photomicrograph of human chromosomes as detailed as those obtained by such a method has been published.

B. M. ŚLIŻYŃSKI.

Department of Biology and Genetics,
Polish Medical School
and Institute of Animal Genetics,
University of Edinburgh.
Feb. 8.

¹ Japa, J., *Brit. J. Exp. Path.*, 23, 272 (1942).

² Japa, J., *Brit. J. Exp. Path.*, 24, 73 (1943).

³ Bauer, H., *Drosophila Information Service*, No. 6 (1936).

Distribution of the Rh Factor in Indians

DURING the course of an inquiry into the incidence of haemolytic anemias in Bombay, it became evident that although a mild form of jaundice was common in the new-born, erythroblastosis foetalis was not encountered in any of the 3,000 consecutive labour cases admitted to the Nowrosjee Wadia Maternity Hospital during the last six months. We were therefore interested in studying the distribution of the Rh factor in Indians. Bloods from 100 Indians were tested against known human anti-Rh sera (technique Taylor¹). The results are tabulated below:

	O		A		B		AB		Total
	Rh+	Rh-	Rh+	Rh-	Rh+	Rh-	Rh+	Rh-	
Hindus:									
Male	12	-	13	-	9	-	4	-	38
Female	12	-	11	-	6	-	3	-	32
Muslims:									
Male	-	-	1	-	-	-	1	-	2
Female	1	-	-	-	1	-	1	-	3
Parses:									
Male	1	-	6	-	1	1	-	-	9
Female	2	-	-	-	2	-	1	-	5
Christians:									
Male	-	-	1	-	-	-	-	-	1
Female	5	-	1	1	3	-	-	-	10
Total	33	-	33	1	22	1	10	-	100
British:									
Male	7	1	6	1	1	-	-	-	16

Bloods from 16 British persons were tested by the same technique to ensure that the anti-*Rh* sera had not deteriorated during transit. Two out of 16 bloods were found to be *Rh*- as anticipated.

These results are reported because of the growing interest in the hæmolytic diseases of the new-born and the findings of Greval and Chowdhary² as well as of Das Gupta³ from the same laboratory that 10 per cent of Indians tested by them were *Rh*-. We believe that the difference between our results and those of other workers in India may be due to the fact that they have been using sera (after suitable dilutions) of animals immunized with red cells of rhesus monkeys. Such immunization leads to the development of anti-*Rh* as well as other agglutinins to a variable extent. It is not certain that the titre of the anti-*Rh* agglutinin is higher than that of other agglutinins in all cases. We believe, therefore, that a dilution of the immune animal serum to any particular extent (without known *Rh*+ and *Rh*- human bloods as controls) is not a justifiable procedure for determining the incidence of the *Rh* factor in any given population. We would recommend the use of immune animal sera which have been absorbed with known *Rh*- red cells for this purpose. Forty-four bloods out of the above hundred were tested with absorbed immune guinea pig serum and gave results identical with those obtained with human anti-*Rh* sera.

In the above series, none of the seventy Hindus tested showed an *Rh*-. One *Rh*- person was found among the fourteen Parsees and one among the eleven Indian Christians. The Hindus constitute 85 per cent of the labour cases in the Maternity Hospital. These findings may suggest interesting anthropological problems. A detailed report of the investigation will be published elsewhere.

We are deeply grateful to Prof. R. A. Fisher for his interest in this work, to Dr. George Taylor, Galton Serum Unit, Cambridge, for the gift of dried human anti-*Rh* sera and to Dr. Janet Vaughan for bringing them to us. We are indebted to the authorities of Nowrosjee Wadia Maternity Hospital and to Major P. Warmold, for facilities in collecting blood samples.

V. R. KHANOLKAR.

L. D. SANGHVI.

Tata Memorial Hospital,
Bombay.
Jan. 18.

¹ Taylor, G. L., *Proc. Soc. Med.*, **36**, 225 (1943).

² Greval, S. D. S., and Roy Chowdhary, A. B., *J. Ind. Med. Assoc.*, **13**, 65 (1943).

³ Das Gupta, C. R., *Ind. Med. Gaz.*, **37**, 372 (1944).

Influence of Sodium Chloride on the Formation of Melanin

VARIOUS widely differing diseased states with two features in common, melanuria and decreased blood sodium chloride, have been reported¹. The inhibiting effect of ascorbic acid on the formation of melanin from tyrosine, 3:4-dihydroxyphenylalanine and adrenaline is well known²⁻⁵. It is also known that the oxidation of ascorbic acid is inhibited by sodium chloride⁶.

The oxidation of tyrosine, 3:4-dihydroxyphenylalanine, tyramine and adrenaline to melanin by tyrosinase, and in the case of 3:4-dihydroxyphenylalanine non-enzymatic oxidation, in the presence of uniform concentration of ascorbic acid but with two different concentrations of sodium chloride, has been

investigated. Substrates have been used at an arbitrary strength of 0.02 per cent; ascorbic acid at the physiological strength of 0.0012 per cent⁷; sodium chloride (a) physiological, 0.9 per cent and (b) 0.5 per cent. In the first two experiments the solutions were adjusted to pH 7.4 with sodium bicarbonate; in the remainder the solutions have been prepared in phosphate buffer electrometrically determined at pH 7.42. Potato tyrosinase has been used throughout.

In the first six experiments the rates of oxidation were estimated by naked-eye comparison of the coloured products. All showed accelerated melanin formation in the solution with the smaller concentration of sodium chloride. Fifteen experiments were carried out in the Warburg apparatus. Again all showed increased rate of oxidation in the solution containing the smaller percentage of sodium chloride. The probability of twenty-one results in the same direction being due to chance is 1 in 1,048,576. The average increase of oxygen uptake by the solution containing 0.5 per cent sodium chloride was 6 per cent, which is a small value in view of the fact that the estimated error of the manometric method is about 2 per cent⁸. Though the statistical significance of these results is beyond doubt, a confirmation by a more delicate method seemed desirable. It was noted that the difference was most marked when dilute enzyme was used, that is, when the conditions approached nearer to the physiological. But dilute enzyme necessarily prolongs the experiment, and it was found that after two and a half hours the risk of bacterial contamination arose. No method of sterilization of the reacting fluids and apparatus being available, this method was abandoned and two experiments carried out with the absorptiometer, using dilute tyrosinase. In the first of these, after four hours, the 0.5 per cent sodium chloride solution showed an increase in oxidation products of 11.5 per cent. In the second, one solution contained 0.9 per cent sodium chloride, the other none. After five hours the solution without sodium chloride contained 25.3 per cent more oxidation products than the other. The absorptiometer is stated to be accurate to within 1 per cent, so there is no doubt as to the reality of these differences.

The above results demonstrate the influence of sodium chloride, with ascorbic acid as an intermediary, on melanin formation *in vitro*. Whether this has any bearing on the physiological production of melanin is a subject for investigation. However, it is considered that it may throw some light on pathological melanin formation. The cause of the hyperpigmentation in Addison's disease has always been a disputed question⁹⁻¹¹. The best-known theory is that of Bloch¹²⁻¹⁴, but this postulates disease of the adrenal medulla, which is by no means always found at autopsy¹¹⁻¹⁶. The following hypothesis is considered to be more in agreement with the autopsy findings in that it attributes the hyperpigmentation to destruction of the cortex. The established facts in Addison's disease are decrease in blood sodium chloride, decrease in ascorbic acid, and increase in production of melanin. It is known that when the cortical activity is diminished the sodium chloride content of the blood falls. It is suggested that as a result of this, the ascorbic acid is not so well protected against oxidation and its concentration also falls. Because of this the melanogen, whichever of the hydroxyphenols it is⁵, is more open to attack by oxidizing enzymes, and increased melanin production takes place.

I am greatly indebted to Prof H S Raper and Dr L P Kendal for valuable advice and access to the absorptiometer in the University of Manchester, and to Capt H Gruneberg for much helpful criticism. The work has been carried out with the aid of a grant from the Government Grant Committee, of the Royal Society.

A J LEA

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Jan 30

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Susceptibility of Grasses to Manganese Deficiency

FROM the literature it would appear that the manganese requirements of the different species of grasses has received but scant attention. In general¹, it is considered that grass is much less susceptible to manganese deficiency-disease than oats and some other crops. That such a generalization is not possible has been shown by a study during the past two years of the comparative sensitivity of various species of grasses. For this purpose, a number of different species of the commoner grasses were grown in a soil-sand mixture in opaque glass pots, the experiment in every detail being conducted in a manner similar to that in which an investigation into the susceptibility of cereal varieties to manganese deficiency had previously been made by Gallagher and Walsh². One experiment was started in 1943 and continued into the following year, the grass herbage being harvested in the autumn. In a further investigation arising out of this experiment, the comparative reaction of some different strains of cocksfoot was examined in 1944. In this experiment a soil growing an oat crop showing 'grey speck', mixed with its own volume of washed silica sand, was used.

In the first experiment the behaviour of perennial and Italian rye-grass, cocksfoot, timothy, annual meadow grass, couch grass (*Agropyron repens*) and fionn was tested. As in the previous experiments with cereals², a series of pots comprising each species were sprayed with a 1 per cent manganese sulphate solution, this treatment being repeated on a different complete series of pots in the following year, those previously sprayed being retained for observations on the residual effect of spraying. Seven strains of cocksfoot were included in the subsequent experiment, these being S 26, S 37, S 143, S 190, S 204 (all Aberystwyth strains), an Irish commercial strain (from the same sample as that used in 1943) and a pedigree strain bred at the Plant Breeding Department, University College, Dublin. Twenty plants

were grown in each pot, triplicate pots being sown in the case of each species and strain.

Perennial and Italian Rye-Grass These grasses reacted in a somewhat similar manner. A month after germination, the younger leaves developed a chlorotic appearance accompanied by severe tip-withering. This condition persisted throughout the 1943 season and was also apparent in the crop of the following year. Spraying when the chlorosis first became evident resulted in the development of a normal green colour. While in the 1943 season Italian was somewhat more severely affected than perennial rye-grass, the opposite held to some extent in the next season, the effect of spraying being particularly evident in the latter instance. No residual effect from the previous year's spraying was noticed.

Annual Meadow Grass and Fionn Both these grasses remained stunted, and no effect resulted from spraying in 1943. In the subsequent year, sprayed fionn plants were considerably greener than the unsprayed.

Timothy Five weeks after germination, these plants were noticed to have a yellow-green colour, and lesions developed on the lower leaves somewhat similar to those characteristic of 'grey speck' in oats. This condition did not become severe, the plants recovering quickly. Sprayed plants were much greener, in addition to being more vigorous, than unsprayed. The chlorosis appeared in the following crop, spraying again being effective as a cure. No residual effect resulted from the previous spraying.

Agropyron repens Early in the season a slight chlorosis accompanied by the development of small grey specks distributed over the leaf blade, and severe tip withering, appeared. Recovery from this effect took place quickly, and though in the initial stages the effect of spraying was quite obvious, later on there was no noticeable difference between sprayed and unsprayed plants. In the following season no chlorosis appeared.

Cocksfoot A month after germination, young leaves were chlorotic and yellow-green spots had developed on the older leaves. A week later, symptoms very similar to those described for 'grey speck' in wheat² had developed, the specks first appearing near the centre of the lamina though sometimes nearer the tip than the base. At first there was a tendency for these specks to coalesce lengthwise forming bands parallel to the veins, but later these bands joined, the result being a withered area across the leaf, the tip then bending over. Eventually the whole leaf withered, the final effect being similar to the end stage of 'grey speck' in wheat or oats². This condition developed to a severe extent and persisted until late in the season. Spraying with manganese sulphate cured this condition, first signs of recovery being evident a week after application. In the following season these symptoms again appeared though not so severely, no residual curative effect being obvious from the previous season's spraying. Spraying again resulted in normal plants.

While it was obvious at an early stage that the plants growing in the soil-sand mixture used in the experiments started in 1944 did not exhibit such pronounced symptoms of manganese deficiency as those in the previous experiment, a definite difference in the behaviour of the different strains of cocksfoot was nevertheless apparent. Again manganese deficiency showed as a chlorosis followed by 'grey speck' symptoms. S 26 and S 204 showed a moderate to severe attack, S 190 and S 143 a moderate, and

the other three strains a slight to moderate attack. It is worth noting that while the Irish commercial strain was severely attacked in 1943, only a slight to moderate attack ensued in 1944, and if this be taken as a basis for comparison, an idea is furnished as to the possible reaction of the other strains under more pronounced manganese-deficient conditions.

This study has, therefore, shown that different grasses react differently to manganese deficiency, further, the effect applies to different strains of at least one grass. The fact that the 1943 investigation was carried out under conditions similar to those which obtained in the previous investigations with different varieties of oats, wheat and barley² enables a comparison to be made of the relative sensitivity to manganese deficiency of these latter crops and the grasses used. This reveals that, depending on species and strain, some grasses may be practically as sensitive to manganese deficiency as the more sensitive oat and wheat varieties, and much more so than the least sensitive of these. Further research in this connexion is proceeding.

I wish to thank Dr Jenkins and Prof Caffrey for providing grass seeds, and Dr P. H. Gallagher for advice.

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Feb 1

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Induction of Heat in Spayed Female Guinea Pigs by Subcutaneous Hormonal Implants

DURING oestrus in the guinea pig, there is a relative hyperaemia at the antimesometrial border of the bicornate uterus¹, and after suitable hormonal treatment similar vascular changes have been induced in the spayed animal^{2,3}. Vaginal cornification, increase in uterine weight, and all the histological features so far recognized of a typical heat response can be elicited in spayed female guinea pigs by a simple administration of oestrogens, but the cyclic vascular change is only displayed after preliminary priming of the animals with small daily injections of oestradiol monobenzoate (0.0005 mgm for six days) followed by a large daily dose (0.5 mgm) for two days and a final injection of progesterone (0.2 mgm). We believe that this antimesometrial hyperaemia in the spayed female guinea pig is not a simple manifestation of oestrogenic activity, but only becomes evident when a hormonal balance approximating to the physiological condition of normal oestrus has been obtained. It is further significant that this antimesometrial hyperaemia is a response of the adult uterus and cannot be induced in the immature guinea pig by either oestrogenic⁴ or gonadotropic⁵ stimulation.

The method of hormonal administration by the subcutaneous implantation of pellets, introduced by Deansley and Parkes⁶, seemed to us to offer an attractive labour-saving alternative to the daily injections, by which the animal would receive a small but continuous dosage with the minimum disturbance.

One 2 mgm oestradiol pellet was inserted subcutaneously by means of a large intravenous needle

in each of twelve adult spayed guinea pigs. Invariably the vagina opened on the third day following the insertion of the pellet, and maximum cornification of the vaginal smears occurred on the sixth day. After six days, half the number of animals were given a subcutaneous injection of 0.2 mgm progesterone, and the other half were similarly treated on the twelfth day. The animals were killed three hours after the progesterone injection. In every case the uterus was enlarged and oedematous, with a thickened endometrium showing tortuous glands here and there dilated with secretion. These oestrous reactions were particularly well marked in the 12-day group of animals. There was, however, never any antimesometrial hyperaemia—a constant feature of the guinea pig uterus during normal oestrus. In an odd uterine section of the 12-day group a localized hyperaemia could be seen on one or other side or at the mesometrial border. We had apparently failed to obtain the necessary hormonal balance to promote the normal vascular change.

It is reasonable to assume that the inevitable fibrous encapsulation of the pellet would impose a decreased rate of absorption. At first there would be a fairly constant rate of absorption with a dosage too high for priming, and then a downward gradient, finally flattening out to a reduced dosage-level. Some such absorption curve is also suggested by Folley⁷. In the normal cycle, on the other hand, oestrogenic activity rises from minimum to maximum, to attain its peak around ovulation time. The priming dose of 0.0005 mgm in our former experiments² did not produce vaginal opening until the sixth day, and was then followed by large doses. Because of its more gradual, more prolonged and culminating high level of oestrogenic stimulation, this method, we believe, conforms more closely to the physiological gradient of hormonal activity during the oestrous cycle.

It can therefore be concluded that (a) the pellet method can provoke all the well-known vaginal and uterine reactions. It cannot, however, elicit the cyclic vascular change (antimesometrial hyperaemia), which provides a particularly delicate test of the complete uterine response to stimulation, but requires for its onset a preliminary sensitization followed by a nicely balanced quantitative interplay of oestrogens and progesterone. (b) The pellet method possesses undoubted advantages where the desired effect can be obtained by the administration of hormones over a long period, for example, to feminize experimentally the plumage growth of the brown Leghorn capon, physiologically to induce lactation in the cow, and clinically in the treatment of infantile uterus.

We have to acknowledge our thanks to Messrs British Schering, Ltd., and also Organon Laboratories, Ltd., for kindly providing us with supplies of progesterone and fused oestradiol pellets respectively.

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MATHEMATICS AT THE NATIONAL PHYSICAL LABORATORY

THE National Physical Laboratory is proposing to extend its activities by the establishment of a Mathematics Division. It may be of interest to sketch the scope of the project as it is at present planned, though the plans may, of course, be modified in the light of growing experience.

The general aim may best be described by an extract from the report of an Interdepartmental Technical Committee recently appointed to consider the advisability of setting up such an establishment. This Committee decided that there is a strong case for an organization which would (1) undertake research into new computing methods and machines, (2) encourage the development of new computing methods and instruments and the dissemination of knowledge of them and of existing methods, (3) deal with problems arising from statistical science, in particular by assisting in the application of statistical methods to research, development and production problems in industry and to problems arising in the physical sciences and engineering, and by research into new statistical techniques, it would in general exclude economic, sociological and biological statistics from its purview, (4) advise on the need for new mathematical tables, and, if necessary, prepare them, (5) provide computing services for Government departments and industry, (6) act as consultant on mathematical matters to Government departments and industry.

The Committee recommended that the National Physical Laboratory should undertake these duties, and with the view of doing so the Mathematics Division is being established. It is proposed at first to organize it in three sections, concerned respectively with computations using existing machines, with statistics, and with work of the differential analyser type, including the construction of new types of machines.

For the computing section there will be a full range of modern calculating machines, including the punched-card type, and very likely new machines may be developed for specialized purposes. There will be a comprehensive library of mathematical tables. Any spare time of the section will be devoted to the tabulation of functions of general utility.

The second section will be concerned with statistical methods and their use in industry. The methods of 'quality control' of production are now well established in industry, and at the practical levels can look after themselves, but there is room for much work in a general oversight of the subject, and in the further study of data provided by 'Q.C.' records. There is also much scope for the use of statistical methods in the planning of experiments in physics and engineering in the same way as is already well established through the work of Fisher and others in the biological sciences. It is not contemplated that the work of the section should extend into biology or sociology, as this would enlarge its scope out of all proportion, and would bring it into fields which are inappropriate for the National Physical Laboratory.

The third section will deal with work using what may be described as analytical engines, including the differential analyser and other machines both existing and awaiting invention. From progress already made elsewhere in such matters, it is certain that this field is capable of great developments, but it

is more difficult to predict in what directions they will lie.

In setting up a Mathematics Division there is no intention of supplanting other existing activities. There are already in the Government service a number of mathematical groups fulfilling important specialized functions, for example, the Nautical Almanac Office. These will continue to work as before, but the new Division should be able to provide service for them by advising on their methods and perhaps assisting them in times of pressure. So too there will be no supersession of industrial work in mathematics, but it is intended that there shall be close co-operation. This should encourage the development inside industry of the use of mathematical methods, which recent experience has undoubtedly shown to be of the greatest value.

BRITISH LIBRARY OF POLITICAL AND ECONOMIC SCIENCE

THE annual report of the British Library of Political and Economic Science, which is housed in the London School of Economics and Political Science, for the year ended July 31, 1944, includes a retrospect of 1933-44. In this ten years the Library added 104,450 bound volumes to its shelves, and 154,368 cards to its author catalogue. During 1934-35 the Library added to its shelves 4,549 treatises and was receiving currently 3,339 periodical titles, as against 5,445 treatises and 4,506 periodicals in 1938-39, the last year of normal working. In the years immediately preceding the War, much was done to strengthen the staff and to improve its status. This larger and more highly qualified staff enabled the whole of the administration of the Library to be reorganized and the services to be greatly improved.

The survey is largely one of the work of 1934-39. Intensive efforts were made with much success to set up an international library truly representative of the social sciences. Many complete sets of important periodicals were secured, and gaps filled in existing sets. A new system of combined work-card and draft-catalogue-card was devised to eliminate wasteful routine tasks, and, in conjunction with a new arrangement of accession registers, was used to enable the Library to check its intake by country and by subject. A revision of the existing catalogue was undertaken, and after nine and a half years intensive work has at last been completed. With regard to cataloguing the uncatalogued material, all the non-official periodicals and almost all the official periodicals held by the Library have been included, 12,732 old pamphlets have also been catalogued, although many times that number still await attention, and 5,482 non-serial official publications have been catalogued and entered in chronological sequence under the issuing department of the relevant Government. In addition, 4,852 cards have been entered for treatises discovered to be in the Library but not in the catalogue. The separate catalogue to the Edward Fry Library of International Law has been revised and some 5,000 duplicate entries inserted in the main catalogue.

One of the many real needs of the Library is an adequate catalogue room to hold not only the rapidly expanding catalogues, but also adjacent thereto a much larger collection of bibliographies and works of reference. The principal stacking problem has been that of space. Reviewing the improvements made in

the housing of readers and the staff of the Library, the survey points out that these improvements led to a heavy increase in the use of the Library. At the conclusion of the War the number of readers wishing to consult the Library's international collections in history, politics, government, economics, law and international law, will undoubtedly present the Library Committee with an anxious and difficult task. A little is being done to improve the lending library established for undergraduate students. The seminar collections, like the present lending library, are too small, and those systems should be developed into real ancillary libraries. The physical damage suffered by the Library and its collection through enemy action has so far been negligible, and despite many changes in the Library staff, which has now only six members who are fully conversant with its activities, work is being carried on in the same spirit as in 1940-41.

According to the annual report for the year ended July 31, 1944, 1,675 works, 1,000 pamphlets, 206 non-serial official reports, excluding British Parliamentary Papers and Public Documents of the United States, were added to the Library, which on July 31, 1944, was receiving currently 2,457 annuals and 1,340 periodicals. It is a subscribing member of twenty-six learned societies. All British Parliamentary Papers are received regularly by the Library, which is also a "library of deposit" for the Public Documents of the United States. The total number of bound volumes now in the Library is 258,360.

CHEMICAL EDUCATION

At a joint meeting of the London Sections of the Royal Institute of Chemistry and the British Association of Chemists, and of the London Area Section of the Association of Scientific Workers, held in London on February 21, a spirited discussion on "Chemical Education" took place. The chair was taken by Dr G. L. Riddell, chairman of the London and South-Eastern Counties Section of the Royal Institute of Chemistry.

Various aspects of the subject were introduced by different speakers. Dr J. R. Nicholls gave his views on the knowledge and skill expected from an analytical chemist. He stressed the need for training in fundamental chemistry and in the principles underlying the various analytical procedures. Speed and accuracy are essential and keen powers of observation are required. He suggested that chemical education should include some account of the factors which determine whether a particular chemical reaction is suitable for use on a large scale, and concluded by regretting that there are no chairs of analytical chemistry at British universities and no academic schools of research in analysis.

Dr F. W. Stoye discussed the requirements of a work's chemist. He said that too high a degree of specialization in a degree course should be discouraged. At the same time, efforts should be made to give students an idea of the similarities and differences between laboratory and works practice by occasional visits to factories. After employment, the graduate chemist should supplement his academic training by courses in technology and ancillary subjects such as costing, factory legislation, etc. He should attempt to improve factory technique while making due allowance for the craft of the operative.

Mr F. A. Robmson spoke on "What is Expected of the Research Chemist". He is of the opinion that the primary requirement is a sound grasp of the principles of scientific research and, secondly, an ability to apply these to whatever problems are encountered. He must also be gifted with a healthy scepticism, inventiveness, patience, the ability to read intelligently and an interest in the utilitarian aspect of his work. The latter quality is, perhaps, most neglected in a university training, and might be fostered by informing the student of technological as well as academic discoveries.

Dr J. Kenyon, speaking on university training, pointed out that chemistry is a wonderful blend of craft and science, and that the training of the chemist is, therefore, twofold in character. In the laboratory the aim is to acquire manipulative skill and develop powers of observation and deduction, while in the lecture room the fundamental principles of the science are acquired. He stressed the importance of the latter, stating that he does not conceive it to be the function of university training to produce youthful specialists ready to fulfil the specific requirements of any particular industry. Its function is rather to supply young men and women capable of applying the results of their training—a skilled hand, an observing eye, a well-stored mind, a critical judgment and a logical intellect—to meet the varied demands of chemical industry.

Dr A. J. Jinkings spoke on the technical training of the chemist. He affirmed that full-time day courses at a university or technical college are somewhat academic in character and that emphasis is rightly placed on principles rather than on applications. Greater co-operation is needed between the universities and technical colleges, and more technical college courses should be regarded as adequate qualifications for a degree. He suggested that a faculty of technology in the University of London and a national technological institute to grant degrees and to co-ordinate and supervise technical training generally would be of outstanding value.

Dr E. A. Rudge paid high tribute to the sterling qualities of the part-time graduate, who, he said, stands high in industrial value. Against the advantages he shows in training and experience, however, are serious disadvantages of narrowness in outlook, since he lacks the experience of academic life. He suggested that this could be overcome by wider provision for part-time day classes which should be integrated, where possible, into the academic course.

The discussion which followed was summarized by Dr C. G. Anderson. A number of contributors said that during university chemical courses a certain amount of technological training and some knowledge of standard forms of plant should be given, so that graduates should not be completely at a loss on entering industry. This training would be helped by interchange between industrial chemists and university teachers, by works visits and vacation employment in industry. Training should also be given in the use of literature. Students should be given some idea of the conditions, requirements and possibilities in industry in order that they may select, to some extent, the type of work for which they are fitted. More attention should be paid to inculcating the scientific outlook quite early in ordinary school training. Part-time evening study, while valuable, is too strenuous, and more day training and State bursaries for full-time study are desirable. The opinion was expressed that there should be refresher courses

in a variety of subjects, and courses for the training of laboratory assistants and stewards, also that industry should provide special training, and apprenticeship schemes for juniors might prove of great advantage

FLAGELLAR MOVEMENTS

THE mechanics of flagellar movements and the swimming of aquatic micro-organisms form a subject of great complexity, towards an understanding of which A. G. Lowndes (*Proc Zool Soc*, 114 (111), 325, 1944) makes a critical contribution in respect of *Monas stigmatica* Pringsheim, *Peranema trichophorum* (Ehrbg.) Stein and *Volvox* sp., and at the same time effectively refutes several statements about this process that have made their appearance in standard text-books of biology

M. stigmatica is exceptionally sensitive to light, and although it swims actively and rapidly in subdued daylight, exposure to the light of an ordinary electric bulb induces a cessation of normal swimming. This, coupled with its high rate of movement, makes observation on, and photography of, flagellar movements and swimming difficult or impossible. Direct observation showed a maximum rate of swimming of 0.260 mm. per sec., that is, more than forty times its own length per sec., but observations of flagellar movement at this rate of swimming were not possible. When the rate of swimming is reduced to about one twenty-sixth of normal, the long flagellum (about two and a half times the length of the cell) is held out in front of the organism, and waves which originate at its base pass regularly along it, at the same time a current is set up in the water, and this flows in the opposite direction (that is, tip to base) and past the anterior end of the organism. This is the condition of the long flagellum when the organism is moving slowly, and in the normally slow-moving *Peranema* the flagellum is also held extended in front of the cell with the anterior end of the flagellum vibrating. Stimulation causes the whole flagellum to beat violently, but this does not bring about an acceleration in the rate of movement of the cell. Instead the organism ceases swimming momentarily, and then changes its direction of movement. Hence statements that *Peranema* exhibits a slow forward movement during which undulations of the flagellum are confined to its anterior end, and a rapid movement accompanied by undulation along the whole length of the flagellum, appear to be incorrect.

Experiments with a physical model, for example, a leather thong rotated under water, show that it is possible to propel from base to apex (that is, from the attached to the free end) of the thong a series of waves of decreasing amplitude and wave-length. With the thong all the energy is applied at one end, but with a flagellum, while most of the energy may be applied to its base by the attached cell, the flagellum itself generates energy so that no decrease in the amplitude or length of waves passing along it need occur. Increasing the speed of rotation of the thong causes it to swing from side to side, and it may finally twist up, but shortening it increases its stability. When two thongs are attached to the arms of a Y-tube which is itself attached to a spindle and the whole rotated rapidly under water, the thongs bend outwards, and if the spindle moves forward the thongs bend backwards. If, however, the spindle is rotated relatively slowly, a current of water is caused

to flow towards the base of the thongs and at this rate of movement the thongs do not bend outwards.

In *Monas*, when the swimming is slow, the flagellum is extended forward, but if the movement is rapid the long flagellum bends and trails behind the cell and causes the organism to gyrate and rotate. It is probable that in other fast-moving organisms the flagella trail behind and are not extended in front of the cell as they are in slow-swimming types. In *Volvox*, a slow-moving cœnobia alga, the pairs of cilia remain fully extended and each pair draws a current of water towards the surface of the cœnobium, but the precise contribution that these currents make towards the movement of the *Volvox* colony is not clear.

L. G. G. WARNE

FOOD IN HOSPITALS

AN interesting article in the *Lancet* (61, Jan 13, 1945) discusses the monotonous, badly cooked and often scanty menus provided by hospitals. The fault lies, the writer concludes, not only with the hospitals, which fail to appreciate the importance of correct feeding and, in most instances, to employ a single experienced food officer with sufficient influence over the hospital's income, but also with the medical men, who do not insist that their patients' needs are properly met.

The quantity of food in hospitals is often insufficient and it has to be eaten in a hurry, for the nurses have to be getting on with the next job. The medical man could criticize the arrangements on all these grounds, and he should do so, paying special attention to the quality of 'light diet', when it is ordered. The blame has to be distributed between the hospital steward, the matron, the cooks, the out-of-date kitchen equipment, the methods of preparing, carving and serving the food, its transport along draughty corridors on unheated trolleys with delays, wilful or inevitable, on the way, and so on. The solution of this problem requires, the writer concludes, a more unified control. The prescription of diets is, and must remain, part of the treatment, the ward sister, who knows her individual patients' likes and dislikes, should interpret the prescriptions, but the buying, cooking and distribution of the food should not be done by three separate officers. Further, adequate meals should be provided throughout the day, inexpert buying and failure to use the open market should be eliminated, sufficient skilled kitchen staff should be provided, and the kitchen should have modern equipment and labour-saving devices.

A second article (*Lancet*, 94, Jan 20, 1945) discusses the question: What is good feeding? The hospital should construe scientific knowledge of food values with the caterer's art of producing appetizing meals. Enough food of the right kind should be economically bought, properly stored and wisely cooked. Individual appetites vary, and those of sick people need special consideration. The lack of the important effects of the sights, smells and talk of the dining table can be counteracted by serving the food attractively. A third article (*Lancet*, 123, Jan 27, 1945) suggests remedies for existing faults, with instances of improvements that have been made. The writer's evident understanding of the difficulties of all who are concerned with hospital food, his sympathy with them and with the patients, and his lively style, make these articles as attractive as they are valuable.

FORTHCOMING EVENTS

Thursday, April 5—Monday, April 9

BRITISH PSYCHOLOGICAL SOCIETY (at the University College of the South-West, Exeter)

Friday, April 6

At 9 30 a.m.—W. D. Furneaux "An Experimental Study of Suggestibility and Hypnosis", Winifred Raphael "Surveys of Employee Attitude" At 11 20 a.m.—Hilda Lewinsky "Psychological Aspects of Cooking for Oneself", W. D. Wall "Reading Backwardness in the Army" At 5 p.m.—Margaret Lowenfeld "The Mosaic Test"

Saturday, April 7

At 9 30 a.m.—Discussion on "Psychological Implications of Culture Patterns" (Prof. T. H. Pear, Dr. A. I. Richards and other speakers) At 5 p.m.—Dr. Millais Culpin. Presidential Address At 8 30 p.m.—Display of Instructional Films arranged by the Visual Education Centre, University College, Exeter

Sunday, April 8

At 2 30 p.m.—An Account of the Work of the Devon Committee for Education in Mental Health and of the Committee of Professional Psychologists (Mental Health) of the British Psychological Society At 5 p.m.—M. D. Vernon "Perception and Understanding of Graphical Material", Charles Burns "Types of Problem Children" At 8 30 p.m.—Alec Rodger "The Work of the Admiralty Psychologists", G. Patrick Meredith "The Problems and Methods of Visual Education"

Monday, April 9

At 9 30 a.m.—Eric Farmer "Problems in the Occupational Adjustment of the Blind", M. I. Dunsdon "The Binet Test as adapted for the Blind" At 11 20 a.m.—I. Langan "Demonstration of Binet Tests for Blind Children" At 11 50 a.m.—M. B. Stott "Some Differences between Boys and Girls in Vocational Guidance" At 5 p.m.—Dr. K. J. W. Craik "Refractory Period in Sensory-motor Action", H. Himmelweit "Level of Aspiration, as related to Neurosis and Temperament" At 8 30 p.m.—Open Session for Discussion

Monday, April 9—Wednesday, April 11

SCIENCE MASTERS' ASSOCIATION (at the City of London School, Victoria Embankment, London, E.C.4) Annual Meeting

Monday, April 9

At 5 15 p.m.—Mr. C. L. Bryant "The Impact of Science on Common Thought" (Presidential Address)

Tuesday, April 10

At 10 a.m.—Dr. J. McG. Bruckshaw "Physics and Economic Geology", Mr. C. Bibby "Health Education through School Biology" At 11 15 a.m.—Sir Alexander Fleming, F.R.S. "Penicillin" At 5 p.m. (at the Ministry of Information Theatre, University of London, Malet Street, London, W.C.1)—Film Show and Discussion, Mr. Arthur Elton "The Scope and Limitations of the Science Teaching Film"

Wednesday, April 11

At 10 a.m.—Mr. F. W. Cuckoo "The Electron Microscope" At 11 15 a.m.—Mr. R. Matland "The Chemistry of Plastics" At 2 p.m.—Discussion on "The Role of Science in the Future Educational System" (Opening speakers: Mr. A. W. Wellings and Mr. D. H. J. Marchant) At 5 30 p.m.—Mr. J. G. Crowther "The Social Relations of Science" (Science and Citizenship Lecture)

Monday, April 9

SOCIETY OF ENGINEERS (at the Geological Society, Burlington House, Piccadilly, London, W.1), at 5 p.m.—Mr. Ian R. Maycock "Aircraft Salvage and Repair"

Tuesday, April 10

ROYAL ANTHROPOLOGICAL INSTITUTE (at 21 Bedford Square, London, W.C.1), at 1 30 p.m.—Prof. B. Zaborski "The Population of Poland"

SHEFFIELD METALLURGICAL ASSOCIATION (at 198 West Street, Sheffield 1), at 6 30 p.m.—Dr. D. W. Davison "Some Crystallographic Effects in Metals"

QUEKETT MICROSCOPICAL CLUB (at the Royal Society, Burlington House, Piccadilly, London, W.1), at 7 30 p.m.—Mr. E. Holloway "Notes on the Rotifers of the Aylesbury District, with special reference to the Seasonal Variation of the Plankton Species, and Freshwater Microscopic Life in General"

Wednesday, April 11

INSTITUTION OF ELECTRICAL ENGINEERS (TRANSMISSION SECTION) (at Savoy Place, Victoria Embankment, London, W.C.2), at 5 30 p.m.—Mr. E. W. W. Double "Distribution of Tensile Load in relation to Temperature and Sag of Steel-cored Aluminium Conductors"

Thursday, April 12

ROYAL COLLEGE OF SURGEONS OF ENGLAND (at Lincoln's Inn Fields, London, W.C.2), at 4 p.m.—Prof. F. Wood Jones, F.R.S. Robert Jones Memorial Lecture—"Some Reflections on his Teaching of Myology"

INSTITUTION OF ELECTRICAL ENGINEERS (INSTALLATIONS SECTION) (at Savoy Place, Victoria Embankment, London, W.C.2), at 5 30 p.m.—Mr. R. O. Ackerley "Factors Influencing the Design of Electric Lighting Installations for Building Interiors"

Thursday, April 12—Friday, April 13

INSTITUTE OF PHYSICS (X-RAY ANALYSIS GROUP) (at the Royal Institution, Albemarle Street, London, W.1)—Conference on "X-Ray Diffraction Analysis"

Friday, April 13

INSTITUTION OF CHEMICAL ENGINEERS (at the Connaught Rooms, Great Queen Street, London, W.C.2), at 11 a.m.—Twenty-third Annual Corporate Meeting At 12 noon—Mr. F. A. Greene "A By-Way in Chemical Engineering" (Presidential Address) At 3 p.m.—Mr. H. W. Cremer and Mr. R. L. Fitt "The Siting and Layout of Industrial Works"

ROYAL ASTRONOMICAL SOCIETY (at Burlington House, Piccadilly, London, W.1), at 4 30 p.m.—Annual General Meeting Prof. E. A. Milne, F.R.S. "The Natural Philosophy of Stellar Structure"

SOCIETY OF CHEMICAL INDUSTRY (PLASTICS GROUP) (joint meeting with the BIRMINGHAM AND MIDLAND SECTION) (at the Chamber of Commerce, New Street, Birmingham), at 6 30 p.m.—Dr. K. W. Pepper and Dr. F. T. Barwell "Fabric-Base Plastics"

APPOINTMENTS VACANT

APPLICATIONS are invited for the following appointments on or before the dates mentioned

FOOD CHEMIST in the Research Department of a well-known London firm, to carry out the analysis of a wide range of food materials packed in metal containers—The Ministry of Labour and National Service Appointments Department, Central (T and S) Register, Room 5/17, Sardinia Street, Kingsway, London, W.C.2 (quoting Reference No. F 2722 XA) (April 14)

SENIOR LIVESTOCK OFFICER to be responsible for the Division of Animal Husbandry in the Department of Agriculture, Government of Jamaica—The Ministry of Labour and National Service, Central (T and S) Register, Room 5/17, Sardinia Street, Kingsway, London, W.C.2 (quoting Reference No. F 3844 A) (April 17)

LECTURER IN METALLURGY, with CHEMISTRY as a subsidiary subject—The Principal, Dudley and Staffordshire Technical College, Dudley (April 18)

DRAINAGE AND IRRIGATION ENGINEER by the Gambia Government—The Ministry of Labour and National Service, Central (T and S) Register, Room 5/17, Sardinia Street, Kingsway, London, W.C.2 (quoting Reference No. F 950 A) (April 18)

LECTURER IN ELECTRICAL ENGINEERING SUBJECTS in the Ipswich School of Technology—The Chief Education Officer, Education Department, 17 Tower Street, Ipswich (April 20)

TEACHER OF MATHEMATICS AND SCIENCE, with duties chiefly in the Junior Building School—The Principal, Technical College, Huddersfield (April 20)

TECHNICAL ADVISER TO THE EXCISE COMMISSIONER, Government of the United Provinces, India (candidates must be highly qualified distillery technologists, specializing in biochemistry of fermentation but with sufficient knowledge of chemical engineering to advise distillers on constructional and allied problems)—The Ministry of Labour and National Service, Central (T and S) Register, Room 5/17, Sardinia Street, Kingsway, London, W.C.2 (quoting Reference No. F 3813 A) (April 21)

LECTURER (full-time) in the DEPARTMENT OF NATURAL SCIENCE (candidates must have an Honours Degree in Zoology at a British University)—The Principal, Derby Technical College, Normanton Road, Derby (April 24)

ASSISTANT LECTURER in WEAVING—The Registrar, College of Technology, Manchester 1 (April 24)

CHEMIST AND ASSAYER in the MINING AND GEOLOGICAL DEPARTMENT, Government of Kenya—The Ministry of Labour and National Service, Central (T and S) Register, Room 5/17, Sardinia Street, Kingsway, London, W.C.2 (quoting Reference No. F 3845 A) (April 28)

TUTOR in PHYSIOLOGY—The Principal, Lady Margaret Hall, Oxford (April 30)

SECOND ASSISTANT REGISTRAR—The Registrar, The University Old Clarendon Building, Oxford (May 5)

ASSISTANT REGISTRARY (full-time)—The Registry, University Registry, Cambridge (marked 'Confidential') (May 12)

LECTURER in MECHANICAL ENGINEERING—The Principal, Heriot Watt College, Edinburgh (May 14)

LECTURER in REFRATORIES in the DEPARTMENT OF METALLURGY—The Registrar, The University, Sheffield (May 14)

UNIVERSITY CHAIR of PSYCHOLOGY tenable at Bedford College—The Academic Registrar, University of London, c/o Richmond College, Richmond, Surrey (May 23)

LECTURESHIP in DESIGN AND ANALYSIS OF SCIENTIFIC EXPERIMENT—The Registrar, University Registry, Oxford (May 26)

ASSISTANT LECTURER in the DEPARTMENT OF CIVIL ENGINEERING—The Registrar, The University, Liverpool (May 28)

LIBRARIAN—The Secretary and Treasurer, University College Dundee (August 31)

TECHNICIAN in the DEPARTMENT OF ANATOMY—The Registrar, King's College, Newcastle-upon-Tyne

GRADUATE in ENGINEERING or PHYSICS to teach PHYSICS and MATHEMATICS in the Abersychan Mining and Technical Institute—The Director of Education, County Hall, Newport, Mon.

NATURE

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WATER SUPPLY IN GREAT BRITAIN

LAST summer, the Government issued a White Paper on water policy in Great Britain, which was dealt with, in connexion with related current discussions, in *Nature* of August 5, 1944, p 159. Since then, there have been frequent references to the subject in Parliament and elsewhere, showing that public opinion was alive to the many vital issues involved. Recently a committee of the Institution of Civil Engineers has produced a valuable "Report on the Government White Paper on a National Policy", and now the Government itself has brought before the House of Commons a Water Bill, where it was subjected to vigorous discussion.

The Bill follows closely the lines of policy indicated in the White Paper, though certain outstanding features are naturally clarified in some degree. On the administrative side, the major features are the vesting of all powers in the Minister of Health, including those which relate to surface waters as well as to underground supplies, coupled with a somewhat hesitating curtailment of the supposed right of the individual to do what he pleases with any underground water he can get. Regarding surface supplies, the intention, no doubt, is to accelerate and cheapen procedure by the substitution of local inquiry under more ordered regulations for the more costly and less fettered proceedings of parliamentary committees. Whether this aim will be accomplished may be in some doubt, in view of the fact that various bodies are given the right to object to the Minister's decision concerning the acquisition of lands and water-rights by water-undertakers, until those decisions have been ratified by Parliament.

A fundamental feature of the Bill is the important position of the Central Advisory Water Committee. The Committee is to advise the Minister (or any other Minister concerned) regarding the conservation and use of water, to consider the operation of enactments which may affect water resources and to make representations thereon, and to advise any Minister on questions relating to water which he may refer to it. Advisory powers could scarcely be drawn more widely. Unfortunately, however, the Bill gives not the slightest inkling of the constitution of this all-important body. The next clause states all too concisely that the Minister may, *by order*, make provision respecting its constitution and procedure. It is scarcely too much to say that on the constitution and working of this Committee the whole success or failure of the Bill will depend, and one might reasonably look for some guarantee that it will consist of men with the highest technical knowledge who will bring unfettered judgment to bear on problems referred to them. Through the work of this Committee the investigation of all problems of water supply in Great Britain should be organized, and the application of its conclusions to the conservation and development of water resources for all purposes should be ensured.

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At the next stage, regional organization for the assessment of resources and the co-ordination of local schemes is to be promoted by the establishment of joint advisory water committees, in regions where the demand is judged to be large in proportion to local resources. This proposal is clearly to be viewed in connexion with the powers to define areas within which the right to abstract underground water is prohibited except by sanction of the Minister, for promoting voluntary or compulsory amalgamations of water undertakings, and for variation of areas of supply. In this case the general constitution, powers and duties of such joint committees are defined, and while it is reasonable (as laid down) that they shall consist mainly of representatives of the water-undertakings and local authorities concerned, it is to be regretted that there is no provision for independent scientific and technical advisers.

Further power of control is provided by clauses for the compulsory purchase of land, either for water-works or for the protection of supplies, and for the enforcement of by-laws designed to protect sources against pollution by any acts of the owners or occupiers of the land from which such supplies may be derived. In practice, this last will largely concern the protection of underground supplies, and will depend for effective application on very detailed geological knowledge to define the areas which the by-laws should control.

An examination of the Bill tends to confirm some of the doubts expressed by the expert committee appointed by the Institution of Civil Engineers in its report on the White Paper. All will agree with the committee's general commendation of the White Paper (which it would doubtless extend to the Bill) as representing a valuable step in the development of official recognition of the vital public importance of water questions. At the same time one feels that the committee has been cautiously reticent in the expression of its views, some of which would probably receive more forceful expression by the members as individuals. While modestly disclaiming its right to express an opinion on policy of a controversial nature, the committee evidently is in no doubt that the control of water should be in the hands of a single central authority, with the fullest scientific and engineering knowledge at its command, with power to formulate policy in the light of such knowledge, and to guide the development of water schemes accordingly. It is in this matter of clearly defined organization and control that the proposals of the White Paper (and the Bill) fail to show complete grip of the requirements, and betray too familiar concern for the susceptibilities of existing organizations.

Beyond this central conception, the valuable comments of the Institution's committee may be reduced almost to the single word—research. It is most stimulating to have so clear an expression, from a source of such authority, of the urgent need for more data and more study. Far more extensive records of rainfall are needed for Great Britain generally, and still more intensive studies of its wide variation within small regions. The great need for river-gauging on a well-organized plan is properly stressed,

and one readily appreciates the committee's doubts whether any such scheme would be likely to develop properly under the proposed river boards. The whole fundamental question of percolation and its relation to the maintenance of underground supplies demands far more extensive investigation than it has yet received in Britain. It is not a matter for the mere application of general principles, but for close and prolonged investigation in representative areas. The importance of the general collection and tabulation of information regarding underground water is properly stressed by the committee, which also does well to direct attention to the fact that much of the most valuable information necessary for preparing maps of underground water-levels is provided by great numbers of private wells, a large proportion of which may soon be abandoned. Their investigation, especially in regard to their seasonal variation, is therefore the more urgent.

It appears likely that the committee would feel satisfied that its views regarding such matters as the assessment of compensation water and the protection of underground supplies are reasonably met by the Bill. In general, the proposals for the collection of data regarding underground sources may be adequate, though it is still far from clear that all the information is to reach a single centre for co-ordination and study. Details of new borings are to be made available to the Geological Survey (under guise of the Committee of the Privy Council for Scientific and Industrial Research), but what is to be the fate of all the information collected by the joint advisory water committees? More especially, what must impress all who have studied the Bill, is the absence of any clear provision for the investigation of surface waters and the problems associated with them, though such sources still provide much the larger part of the water supply of Great Britain. The White Paper indicated the need for extending the work of the Inland Water Survey—though it confused the issue by stating that the Survey's most vital work of river gauging should be undertaken by the river boards. In the Bill no such matter is specifically mentioned, and one is left to hope that this and many other things may be included under the Minister's general duty to promote "a national policy relating to water".

The last of the valuable proposals by the committee of the Institution of Civil Engineers is for the appointment of a research committee to co-ordinate work relating to water problems, as it may be conducted in various Government departments, in the universities or by water undertakings. Here, surely, should lie one of the most important functions of the Central Advisory Water Committee. If that committee is constituted of men of unquestioned independence, experience and knowledge, representing the various branches of administration, science and engineering involved, we shall have every reason to hope that the good intentions which undoubtedly lie behind the Bill will really be translated into practice. Here, if anywhere, we may find the 'single authority' which should be responsible for the water policy of Great Britain.

PROBLEMS OF THE LOCATION OF INDUSTRY

CRITICISM of the Distribution of Industry Bill in the House of Commons on March 21 appeared to centre essentially on two points, which found expression in the amendment moved by Sir George Schuster but afterwards withdrawn when the Minister of Production had made a statement first, that no steps have been taken to establish a central independent tribunal to consider the national position as a whole, as recommended in the report of the Barlow Commission, and, secondly, that there has been no satisfactory implementation of the Government's intentions, as set forth in the White Paper on Employment Policy, that the Board of Trade should be suitably strengthened to undertake the new responsibilities proposed in the Bill. Sir George Schuster, in moving his amendment, made it clear that he only supported the Barlow Commission's recommendation for a central authority to review the position of the country as a whole and to make research into all those factors which affect the location of industry, in so far as such an authority stood outside the political field and was capable of an independent and objective review of the position, and of keeping it under constant survey. He did not advocate the establishment of an independent authority with large powers outside the control of Parliament, and in so far as Mr Lyttleton accepted the view that a large conspectus was required, there may be no more difference between his position and Sir George Schuster's than between the majority and minority recommendations of the Barlow Report regarding the constitution and functions of the national authority.

That difference, however, was, in effect, as to whether the central planning authority or national industrial board should be a purely advisory body, or whether a separate executive department presided over by a Cabinet Minister should be created. The need for such an authority was not in dispute. It is the reluctance of the Government to implement the recommendation that it professes to accept which causes uneasiness, and Mr Lyttleton's remarks about the impracticability of an independent authority appear to be little more than a quibble designed to cover indecision on the part of the Government. The question is essentially that of relating knowledge and action, and the fear that action may be determined by prejudice rather than knowledge underlies much of the criticism of the Distribution of Industry Bill.

There was little in Mr Lyttleton's speech to indicate adequate appreciation that much research and collection of factual data are necessary as a foundation for an effective national policy. That was Sir George Schuster's main point. All areas of Britain require consideration as part of a national plan, since all are, in a sense, development areas in this time of immense technical and scientific advance. Proper surveys are required in all regions if we are to determine our broad objectives and first steps.

Apart from the surveys in the special areas, a good deal has already been done in regional surveys. Besides the surveys of West Cumberland and of South Wales for which Colonel W. C. Devereux has been responsible and to which Mr Dalton also referred, Sir George Schuster mentioned work done by the West Midland Group in surveying the Midlands area, and a survey by a Thames-side group of industrialists. Even the more limited surveys, such as those on which the "Plan for Merseyside" is based, require linking to larger regional surveys of, for example, south Lancashire as a whole, and the failure to relate schemes such as the Tummel-Garry project or the Gairloch project prepared under the Hydroelectric Development (Scotland) Act of 1943 to an adequate national and regional planning scheme in which the location of industry is considered in relation to the utilization of national resources as a whole and not merely of water power is, to say the least, far from reassuring.

Besides these, the Northern Industrial Group, formed in 1943 to develop and promote the prosperity of existing industry generally, including the basic industries on which the north-east of England depends for the bulk of its employment, and to encourage commercial, technical and industrial research with the view of developing ancillaries to the basic industries and to attract and help to establish new industries, while sponsoring no formal surveys, has done something to elucidate the action required to prevent the recurrence of depressed areas. Its recently issued "Memorandum on the Government White Paper on Employment Policy", like its earlier memorandum, "Considerations Affecting Post-War Employment in the North-East", shows the extent to which industry itself is already prepared to advise and co-operate with the Government in respect of industrial needs and development in relation to local and national plans.

So far as the location of industry and the development of the north-east of England as a balanced unit are concerned, this latest memorandum urges that whatever administrative system is evolved by legislation in future must take all the relevant factors more carefully into account than has been done under the war-time controls. Besides urging the working out in greater detail of the application of 'negative licensing', the memorandum points out that, in framing a long-term policy, it is essential for the Government to make its decisions on policy now, so that industry may know how to plan for the future even if the date when plans can be put into effect must remain undecided. In particular, the memorandum calls for an early decision on the general policy for location of industry, transport facilities, etc. Immediate arrangements are required for more extensive factory construction in the north-east, including the reconversion of factories in the area from war to peace production, licences to build for firms who have chosen their own sites in the area, and information as to when these are likely to be granted, and the provision of adequate housing for operatives and administrative and technical staff. Existing responsibilities of the Commissioner for the

Special Areas should be transferred to the Board of Trade, and a single agency appointed to act on behalf of the Government in regard to existing or proposed Government factories or buildings, any regional organization established for dealing with the reconversion of industry should consist of Government representatives only, with full executive powers, but advised by a parallel group representing employers, employees and other interests in the area.

The Northern Industrial Group, and the more recently formed North-East Development Association, are clearly well qualified to advise in many ways any Government regional organization which may be established, but this evidence that industry is prepared and anxious to co-operate only gives greater force to the two critical conditions brought out in the recent House of Commons debate—an adequate central planning authority competent to make the broad policy decisions required, and a staff qualified to exercise the positive functions necessary to stimulate and not repress enterprise—and, it might be added, alert to check any restriction or restraint of trade masquerading under the title of development or any other catchword.

Sir George Schuster insisted on the need for some central authority to fit together the results of the regional surveys into a national survey, though he also stressed the need for liberty for all regions to develop within certain broad limits, both these points are widely enough held to represent a broad consensus of opinion. That consensus is scarcely recognized or accepted by the Government as yet, in spite of Mr Dalton's claims that the Bill represents the largest common measure of agreement in the Government itself. The need is not met entirely by the Location Planning Room which has been transferred from the Ministry of Production to the Board of Trade as a joint responsibility of the two Departments. It is true that, as Mr Lyttleton said, this valuable experiment will offer industry an information service regarding location which has never been available before, and that it will relieve industrialists of much of the burden of primary inquiries and thus facilitate decision. It is also in accord with a main recommendation in the Barlow Report. But it is equally clear from the debate that the operation and development of this planning room and all it stands for by the Board of Trade will be regarded with misgivings or scepticism by industrialists until there is evidence that the Board is being strengthened in the way that the White Paper on Employment Policy indicated.

Although Sir George Schuster pressed for central guidance, he also insisted on the need for a spirit of co-operation between industry and Government, with industry being given the information which would enable it to respond intelligently to the Government's policy and guidance. No two things would do more to secure that than evidence first, that the Government has a central policy in regard to the location of industry, with all that is involved in the related problems of the control of land use, town and country planning, agriculture, and building, and secondly, that efforts were being made to equip the Board of Trade—and other departments—with the type of Civil servant qualified by training, outlook and experience to deal with these

positive functions of government with imagination, decision and courage. By removing the fear of mere restrictionism, this second step would go far to remove the misgivings with which this first measure of control of location of industry has been received, but until the Government has offered some clear proof that it is willing and able to deal courageously and constructively with the central issues involved, no improvement in staffing of Government departments or co-operation on the part of industry will avail to avoid the wastage of national resources or the recrudescence of derelict areas in the years immediately ahead.

MODERN STATISTICAL METHODS IN INDUSTRY

Sampling Inspection Tables

Single and Double Sampling By Harold F. Dodge and Harry G. Romig. Pp. vi+106 (New York: John Wiley and Sons, Inc., London: Chapman and Hall, Ltd., 1944) 150-dollars.

Regression Analysis of Production Costs and Factory Operations

By Philip Lyle. Pp. xii+208 (Edinburgh and London: Oliver and Boyd, 1944) 15s net.

FOR about twenty years, statistical methods have been finding their way into the control of industrial processes. In the 1920's only slow progress was made against a great deal of doubt and opposition from manufacturers themselves. About 1932 the tide began to flow more strongly and increased in force as the modern methods were found to provide not merely a new way of formulating old knowledge but also a technique involving substantial saving in labour and money. The War itself has probably done more in six years than peace would have done in sixty to promote the widespread adoption of the new methods. In 1935 a few enthusiasts in Great Britain were still trying to persuade manufacturers of the power of the new tools at their disposal, in 1945 there is a division of the Ministry of Supply encouraging research in these tools and acting as the centre of an extensive network of quality control.

The volumes under review are interesting examples of the use of methods involving the theories of statistics and probability in two rather different branches of the industrial process. Mr Dodge and Mr Romig are concerned with economy in inspection of a mass-produced article and the guarantee of quality to the consumer. Mr Lyle is concerned mainly with the dissection of costs in a manufacturing plant and their relation to output and utilization of production factors.

The four Dodge-Romig tables are prefaced by what are virtually reprints of articles in the *Bell System Technical Journal* in which they were originally published. The tables have been in general demand since the outbreak of war, and their issue under one cover will be welcome.

There are two main reasons why inspection on a sampling plan is necessary in certain types of industrial process. The first is that test-inspection may destroy the sample, as for example in dealing with ammunition, the only satisfactory way of testing a round being to fire it. Secondly, the sheer volume of production and expense of inspection may make it

a physical or financial impossibility to examine more than a proportion of the output. Dodge and Romig are concerned mainly with the second class of case.

The so-called system of *single* sampling lays down a routine on the following lines: the product comes forward from the factory in aggregates known as 'lots'. A sample of specified size n is taken from each lot and examined. If it does not contain more than a specified number c of rejects, the lot is accepted in total. If it does contain more, the lot is completely inspected and rejects eliminated. The *double* sampling process is more elaborate. From any lot a first sample of n_1 is chosen. If the number of rejects does not exceed some level c_1 the lot is accepted. If it exceeds some number c_2 , the lot is inspected in full. If it lies between c_1 and c_2 a second sample of n_2 pieces is taken and inspected. If the number of rejects in this second sample does not exceed c_2 , the lot is accepted, in the contrary case it is inspected in full.

In either process there is a possibility that lots will be passed which fail to fall below some specified tolerance level. The probability that this is so is the 'consumer's risk' of getting an unsatisfactory lot. In the single-sampling tables it is taken as 10 per cent. For any specified tolerance limit and consumer's risk it is possible to find what number c should be determined as the acceptance level with a given sample size n , but either c or n is still at choice. Dodge and Romig determine those values which make the necessary number of inspections a minimum.

A further concept due to the authors is that of AOQL (or 'average outgoing quality limit'), that is to say, the average proportion defective in the material *after inspection and the replacement of rejects where inspection is carried out in full*. The single-sampling tables give this quantity and thus provide, for specified sizes of the lot, lot-tolerances, process averages (that is, population values of the proportion of rejects) and a consumer's risk of 10 per cent, the appropriate sample size n and the acceptance number c which will minimize the inspection required. The first of the double-sampling tables is on the same lines but of course specifies the two acceptance numbers c_1 and c_2 . There are two further tables of a similar character based on specified 'average outgoing quality' limits instead of lot tolerances.

The computation of the tables was no easy task, even with the help of various approximations. The values given are no doubt sufficiently accurate for working purposes, but it seems possible that the methods employed of arriving at them are capable of improvement and refinement. The whole subject furnishes an interesting field for research in practical mathematics, and in the meantime the Dodge-Romig tables continue to do first-class service to industry.

The most encouraging feature of Mr Lyle's book is that it is written, not by a statistician, but by a practical industrialist who has proved the value of regression analysis in his own field. One of the better ways of learning statistical methods is to write a good book about them, and that is what Mr Lyle has done.

In many respects sugar refining is an excellent industry on which to test and to illustrate regression analysis. The final product, perhaps the purest known to commerce, has a standard which is easily measurable. Apart from molasses, there are no other end-products to complicate the allocation of costs. The

factory operations are relatively simple, and Mr Lyle has only to consider in his main analysis of operating costs the factors of labour, fuel and factory overheads (in which he includes maintenance and renewal of machinery). In fact, sugar refining can claim to be the hydrogen atom of industrial production, the simple model exhibiting the essentials of the theory with a minimum of complications.

Mr Lyle considers in the first place a comparatively short period of forty weeks, and shows how to represent the weekly output as a linear function of the weekly cost and to test the significance of the results. He proceeds to more complicated cases by introducing further variates, including non-linear terms, and discusses the accuracy of the estimates in terms of fiducial limit bands (which for this purpose are identical with confidence intervals). He then deals with long-term changes in the production costs, has a few pages on price- and wage-levels, discusses unit costs and concludes with a number of appendixes on notation and the technique of correlation and regressive analysis. In effect, Mr Lyle shows in a most illuminating way how the statistician can take up the inquiry into production costs at the point where the cost-accountant has to lay it down.

The book is not intended as a statistical text-book but as an introduction to such a book. Nevertheless, it provides one of the best exemplifications of a particular branch of theory I have seen. In feeling his way into the subject Mr Lyle has encountered a number of practical difficulties, such as the effect of outliers on the regression line, which are apt to be glossed over in theoretical treatments. He has, quite rightly, dealt with them at some length and managed to achieve an excellent balance between theory and practice. It is to be hoped that he will be successful in his main object of "trying to interest industrial workers in a very useful subject of the very existence of which many of them are quite unaware".

M G KENDALL

THE FLORA OF THE PACIFIC STATES OF AMERICA

Illustrated Flora of the Pacific States

Washington, Oregon and California. By Leroy Abrams. In 4 vols. Vol 2. Polygonaceae to Krameriaceae, Buckwheats to Kramerias. Pp viii + 635. (Stanford University, Calif. Stanford University Press, London. Oxford University Press, 1944.) 45s. 6d. net.

THE region of the Pacific States with which the book under review deals is of great interest to the student of geographical distribution and the taxonomist. The area is peculiarly rich in endemic genera and species, and this is especially true of California. The Pacific States show interesting geographical connexions with the flora of Eastern Asia in genera, however, which are probably too recent in origin to be adduced in support of any hypothesis of continental drift, but are to be regarded rather as evidence of the similarity of ecological conditions and the high efficiency of dispersal agents, not perhaps excluding man himself. Thus the saxifrageous species *Leptarrhena pyrolifolia* is native both to the coastal regions of north-west America and to eastern Asia. Again, the genus *Pectantra* comprises five species of which three are endemic to the Pacific

RITUAL PROHIBITIONS IN PRIMITIVE SOCIETIES

Taboo

A Sociological Study By Dr Hutton Webster
Pp xii+393 (Stanford University, Calif Stanford
University Press, London Oxford University
Press, 1942) 24s net

States, whereas the other two are natives of Japan. But it is in the endemics of the region that the chief interest of the flora rests. Some of these, such as *Romneya Coulteri*, the genera *Eschscholtzia* and *Lewisia*, are familiar to British horticulturists. In the family Polygonaceæ the monotypic genera *Gutmannia*, *Nemacaulis* and *Hollisteria* are all endemic to California while of the 150 known species of *Eriogonum* 80 are found in the Pacific States, many of them endemic. In the Crassulaceæ there are some 35 endemic species belonging to the genera *Sedella*, *Budleya*, *Stylophyllum*, *Hasseanthus* and *Gormania*. In the Cruciferae most of the species of *Thelypodium*, *Streptanthus* and *Caulanthus* are endemic. The Rosaceæ, too, provide a large number of endemics, particularly in the genera *Horseshoe* (19 spp) and *Ivesia* (17 spp). In the Leguminosæ the outstanding genera in this respect are *Lupinus*, of which 58 species are probably endemic, *Hosackia*, of which most of the 39 species are endemic, while *Astragalus* is represented by 137 species of which 83 are probably endemic.

It is obvious therefore that botanists generally will warmly welcome the appearance of the second volume of Prof. Abrams' monumental work. The first volume appeared in 1926 and dealt mainly with the vascular cryptogams and the monocotyledons. The present volume comprises the families belonging to the Polygonales, the Centrospermes, the Ranales, the Rhodales and the Rosales and contains generic and specific keys, descriptions and illustrations of 1,663 species. The figures are in general good, but some of those reproduced from Britten and Brown's Flora might well have been replaced, such as those of *Dryas drummondii*, *Lychnis coronaria* and *Rumex pulcher*, where the characteristic appearance of the species had quite evaded the artist.

The plan of the Flora and the concept of species which is adopted is very similar to that in Britten and Brown's "Illustrated Flora of the North United States and Canada." It is therefore of some interest to compare the plant populations as presented in these two works. The richness of a flora in species is related on one hand to the size of the area concerned and on the other to the diversity of ecological conditions which it presents.

Britten and Brown's Flora treats of a vast area of some two million square miles, ranging from the Atlantic to the 102nd meridian and from south Virginia to the Arctic. The Pacific States, on the other hand, comprise an area of only 323,000 square miles, but include mountains rising to an elevation of more than 14,000 ft and a southern limit that extends beyond the Tropic of Cancer. Moreover, the geology is very varied in character. It is therefore of interest to note that, even in the families with which the volume under review is concerned and which are mostly north temperate in their climatic requirements, the number of species is about 50 per cent larger than for the northern States and Canada. In the Rosaceæ alone does the Pacific State flora lag behind. In the Polygonaceæ and Leguminosæ, the Pacific States have more than double the number of species, while in the Saxifragaceæ, Papaveraceæ and Portulacaceæ there are three times as many.

All botanical libraries will no doubt wish to add this volume for its own sake, but their straitened finances will enhance appreciation of the public spirit of those through whose financial assistance it has been possible to place this work on sale at so low a price.

E. J. SALISBURY.

PROF. HUTTON WEBSTER is well known from his earlier books on "Primitive Secret Societies" and on "Rest Days." His new book, on "Taboo", collects together from ethnographical literature a mass of data concerning the ritual prohibitions found in what are commonly called 'primitive societies'. His aim, as stated by himself, is "to show how important a place taboos hold in the cultural evolution of mankind." The author's definition is as follows: "Taboos form a specific series of thou-shalt-nots. They are not to be confused (as in popular usage) with social conventions and regulations of a negative sort, conventions and regulations without an obvious utility. They are to be distinguished from restrictions resting on the vague notion of unluckiness which attaches to certain acts or things or times, restrictions found in the lower culture and, under the attenuated form of a survival, lingering among ourselves. More important still, there are innumerable prohibitions, both animistic and non-animistic in character, which must likewise be excluded from the conception of taboo if this is to possess any scientific validity and retain a place in ethnological theory. Taboos are prohibitions which, when violated, produce automatically in the offender a state of ritual disability—'taboo sickness'—only relieved, when relief is possible, by a ceremony of purification."

Prohibitions relating to the reproductive life, the relations of the sexes, death and the dead, strangers and strange phenomena, sacred persons and sacred things are dealt with in separate chapters and there are more general chapters on sin and ritual defilement, on the economic aspects of taboo and on its social aspects.

What anthropological science needs is a satisfactory general theory of taboo, or better still a theory of ritual prohibitions in general. Such a theory should enable us to understand not only the widespread existence of such prohibitions, but also the forms they take. Interesting as the present work may be as a collection of examples, it fails to make any contribution to anthropological or sociological theory. Prof. Webster regards taboos in general as arising from the fears and forebodings that beset "primitive man" in an "unfriendly world." The fears themselves "are often the product of a lively imagination and of an abysmal ignorance." Taboos "reflect", he says, "man's ignorance of his surroundings, whether natural or what we call supernatural. They are rooted in the fear of the unknown and the unknowable."

It is evident that the statement that taboos result from man's ignorance and fear does not provide any explanation. It does not, for example, give any reason for those ideas of ritual defilement or pollution which Prof. Webster himself regards as an essential characteristic of taboos.

Perhaps it is unjust to criticize the author for not doing what he does not set out to do. He has given us an extensive compilation of illustrative instances of taboos. The theoretical problem of the nature and function of these prohibitions remains just where it was.

A. R. RADCLIFFE-BROWN

RUBBERS AND THEIR CHARACTERISTICS: REAL AND IDEAL*

By DR. L. R. G. TRELOAR

British Rubber Producers' Research Association

Chemical Structure of Rubbers

NATURAL rubber, extracted from latex by coagulation with acid, and afterwards washed and rolled, appears on the market as crepe or smoked sheet. Raw rubber, as these materials are called, is essentially a hydrocarbon (C_5H_8)_n having the chemical structure shown in Fig 1. It is a polymer of isoprene, the isoprene units being joined together in the form of a long chain. The actual length of the molecular chain, or *molecular weight*, of rubber has been the subject of much discussion, estimates obtained by different methods having ranged from about 1,000 to about 500,000, and it is only within the last few years that the question has been settled. The reliable measurements of Dr G Gee show that the mean molecular weight of a typical raw rubber is about 350,000, corresponding to a chain of about five thousand isoprene units.

This long-chain molecular structure accounts for the very high viscosity of rubber solutions in ordinary solvents like benzene. We imagine that the resistance to flow is due largely to the mutual interferences and loose entanglements between these very long molecules. However, raw rubber is ultimately completely soluble, and we conclude, therefore, that the molecules are not in any way chemically joined together.

It is otherwise with vulcanized rubber, which swells considerably in solvents (to five or ten times its original size), as if it were trying to dissolve, and yet does not go into solution at all. In this case it is reasonable to suppose that the vulcanization (that is, chemical combination with sulphur) has led to a cross-linking of the molecules (see below).

Fig 1 is intended to show the diversity of chemical composition of materials which, under certain conditions, show rubber-like elasticity. Whereas most practical rubbers are built up on a chain of carbon atoms, this is by no means an essential feature, as the examples of gelatin and elastic sulphur show. The important and invariable feature of all rubbers is the pattern of their molecular structure, there is no highly elastic material, so far as I am aware, which is not built up of very long chain-like molecules.

Origin of the Elasticity

Until about twelve years ago, none of the theories of the elasticity of rubber which had been proposed could be regarded as even approximately satisfactory. Attempts to interpret long-range elasticity on the basis of interatomic forces were manifestly inadequate, and it was not until Meyer, v Susich and Valko introduced the conception of a *dynamac*, in contrast to a *static*, basis for the phenomenon that the mystery was solved. The theory developed rapidly through the work of Guth and Mark and of Kuhn, and is now generally accepted as representing the correct method of approach.

To understand the kinetic point of view we must first examine the form of a long-chain molecule, considered as an isolated unit. For this purpose it is usual to consider the simplest possible chain structure, namely, the paraffin molecule. The assumption is

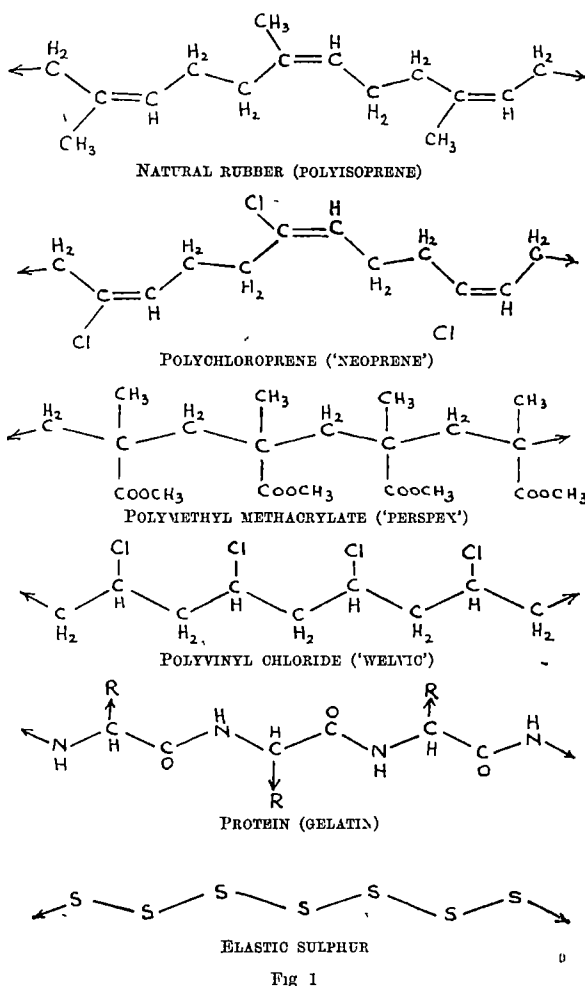


Fig 1

made that the carbon atoms of the chain are in a state of continual thermal vibration, so that they may take up any relative positions consistent with the maintenance of a fixed bond-length and a fixed angle between bonds ($109\frac{1}{2}^\circ$). According to this assumption, each C—C bond may be regarded as rotating freely about the preceding bond as axis. There is chemical evidence that such rotation does take place. In consequence of this random rotation about bonds, the chain will not be a uniform zigzag in one plane, as in Fig 2a, but will assume a randomly kinked form in three dimensions, as indicated in Fig 2b. The distance between the ends of the chain in this form is likely to be very much less than the outstretched length of the molecule in Fig 2a, and the statistical treatment of the problem enables the probability of any given end-to-end distance to be calculated. The function representing this probability turns out to be the ordinary Gaussian error function,

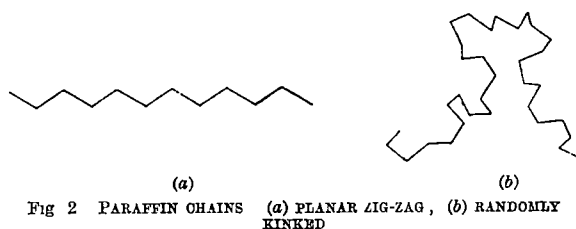


Fig 2 PARAFFIN CHAINS (a) PLANAR ZIG-ZAG, (b) RANDOMLY KINKED

* Royal Institution discourse delivered on December 15

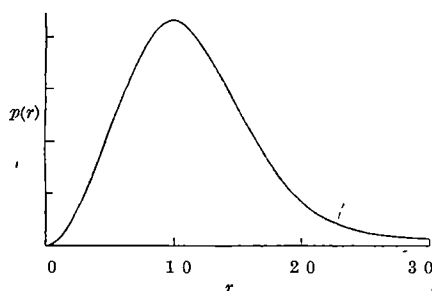


Fig 3 FUNCTION REPRESENTING THE PROBABILITY $p(r)$ THAT A MOLECULE HAS THE LENGTH r

which is represented in Fig 3. The normal state of the free molecule may be identified with the maximum of this curve, that is, it is the most probable state, and the corresponding length is found to be proportional to the square root of the number of 'links' in the chain.

We see, then, that if the molecule is forcibly extended, and then released the random thermal motion will rapidly restore it to a length not very different from the statistically most probable length. The molecule, therefore, exhibits elasticity. Moreover, its elastic extensibility is proportional to the square root of the number of chain links, or the molecular weight. This theory, therefore, explains in a natural manner why long-range extensibility is found only in association with chain-like molecules of very great length.

The thermodynamic development of the kinetic theory leads to some rather striking conclusions. Two of the more important of these are

(a) In rubber held at constant extension, the tension is proportional to the absolute temperature.

(b) The extension of rubber takes place without change in its internal energy, hence there is an evolution of heat equal to the work done on the rubber by the stretching force.

In these two respects the behaviour of rubbers is closely analogous to that of a gas. The agreement with experiment which is found provides very strong evidence in favour of the theory.

The Ideal Rubber

Thus far our attention has been focused on the individual molecule. We have yet to consider in more detail how the elastic properties of the molecule are to be conveyed to the material in bulk. When we consider this problem, we see that in order to be able to take up a variety of statistical forms in the way required by the theory, the molecular chains must have a freedom of movement comparable with that in a liquid. On the other hand, for the rubber to maintain a permanent shape, and to resist applied stresses, the molecules must somehow be fixed in their average positions relatively to one another. To meet these two rather contradictory requirements it is necessary to think of the molecules as linked together by a relatively small number of unbreakable bonds. These will be present in sufficient numbers to produce a complete, three-dimensional network throughout the material, but owing to the great length of the chains they need not seriously impede the freedom of motion of the segments of molecules between such points of junction.

We are thus led to postulate three necessary conditions for the occurrence of rubber-like elasticity, namely

- (1) The presence of long-chain molecules, with freely rotating links
- (2) Weak secondary forces around these molecules
- (3) A few points of cross-linkage, resulting in a loose 3-dimensional network

The ideal rubber may be thought of as a permanent network of long-chain molecules held together by unbreakable bonds, but otherwise completely free to move. The stress-strain properties of such an ideal network have been worked out by a number of authors. The most satisfactory development in this direction is due to Wall (1942), who obtained the following equations for the case of a simple elongation (or uni-directional compression) and simple shear respectively.

For elongation,

$$F_a = NkT \left(\alpha - \frac{1}{\alpha^2} \right),$$

where F_a is stretching force, referred to original section of 1 cm²; N is number of 'molecules', a 'molecule' being the length of chain between its points of junction to the network, k is Boltzmann's constant, T is absolute temperature, and α is the ratio of stretched to unstretched length.

For simple shear,

$$F_s = NkT\sigma,$$

where F_s is shear stress and σ is amount of shear.

There are a number of particularly interesting features of these equations. First, the stress-strain curve for elongation is non-linear, that is, Hooke's Law does not apply, while for shear the relation is linear. Secondly, the only molecular property which enters into these equations is N , the number of chain elements in the network. This quantity is simply related to the 'molecular weight' of the chain. The precise constitution of the molecule or the number of freely rotating links which it contains is of no significance in this connexion. The third point, which is related to this, is that one physical constant only is sufficient to define the elastic properties of a highly elastic material.

I have extended the elastic network theory to the case of a deformation of any type, and shown experi-

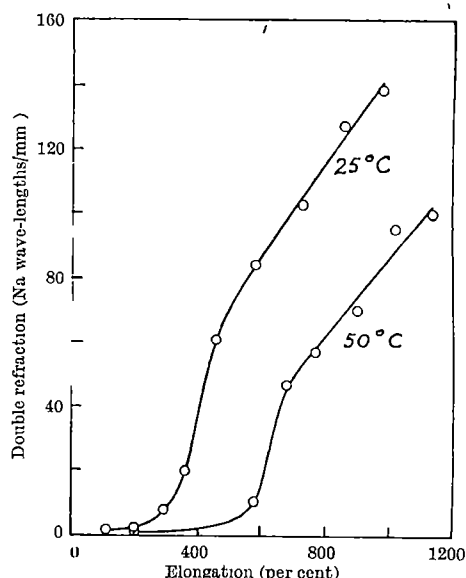


Fig 4 DOUBLE REFRACTION IN RAW RUBBER. EACH POINT REFERS TO A FRESH PIECE OF SHEET HELD AT THE APPROPRIATE EXTENSION FOR ONE HOUR.

mentally that the resultant equations give a reasonably satisfactory account of the properties of well-vulcanized rubber under a number of different types of deformation, except under very high strains, when the underlying assumptions of the theory are no longer applicable

Application to Real Materials

Having now defined the conditions under which rubber-like behaviour is to be expected, let us inquire to what extent real materials satisfy these conditions, and the way in which the non-fulfilment of these conditions leads to departures from the simple behaviour of the ideal rubber

The first point of difference is that in practice rubber-like properties appear only within a certain range of temperature. At low temperatures rubbers are transformed to a glass-hard condition. Below the transition temperature the molecular chains become immobile, the thermal energy no longer being sufficient to overcome the secondary forces between the molecules. For a material like natural rubber, these secondary forces are relatively weak, and the transition temperature is very low (-70°C). If the intermolecular forces are comparatively strong, the transition temperature is very much higher. This is exemplified by polymethylmethacrylate (Fig 1), which is a glass at normal temperatures (being extensively used for its non-splintering property), but becomes highly elastic above about 70°C .

Rubber-like properties may also be lost at high temperatures, where, in the case of polymers which are not cross-linked, the molecules become sufficiently mobile to slide bodily past one another, the rubber thus becoming a viscous liquid. The longer the molecules, the higher the temperature at which this effect becomes noticeable.

This plastic property of rubber and the 'thermo-plastics' is made use of in the processes of moulding, extrusion, etc. In the case of rubber the final form is 'fixed' by vulcanization—that is, combination with sulphur—which leads to a chemical cross-linking of the molecules.

Crystallization

So far I have omitted one very important phenomenon which profoundly affects the mechanical behaviour of rubber, namely, crystallization. If raw rubber is held at temperatures below 0°C for several days, it becomes comparatively hard and inelastic, and at the same time loses its transparency. This state is not to be confused with the glassy state, which occurs on quickly cooling to very much lower temperatures. The X-ray diffraction pattern of normal 'amorphous' rubber is like that of a liquid, there being only a single broad halo present. The same pattern is given in the glass-hard state. But the slowly frozen rubber shows a number of well-defined rings, which are to be interpreted as due to the presence of crystallites oriented at random, as in a powder.

Owing to the enormous length of the molecules, there are significant differences between the process of crystallization in rubber and in an ordinary low-molecular liquid. The crystallites are separated by regions of 'amorphous' or disordered molecules (crystallization is never complete), and, furthermore, a single molecule may pass alternately through several crystalline and amorphous regions. Thus the crystallites are bound together by amorphous rubber. This

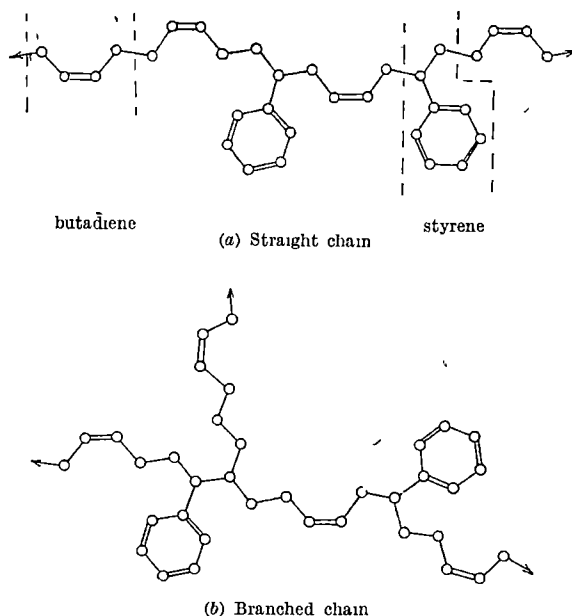


Fig 5 POSSIBLE CHAIN FORMS FOR SYNTHETIC RUBBER GR-S (BUTADIENE-STYRENE POLYMER)

intimate binding of amorphous and crystalline components leads to a certain indefiniteness in the melting point of the crystalline phase, but at the same time imparts a degree of flexibility or toughness which is normally absent from crystalline bodies. The peculiar advantages of this type of molecular structure are made use of in polyethylene, which is chemically the same as paraffin wax, but has a much higher molecular weight. It is flexible, yet sufficiently hard for use as a cable-insulating material, and since the crystals hold the structure together vulcanization is unnecessary. The exceptionally valuable dielectric properties of the pure hydrocarbon are thus unimpaired.

Crystallization occurs not only in unstretched rubber at low temperatures, but also in stretched rubber at ordinary temperatures. By stretching, the molecules are brought into an approximately parallel arrangement, which greatly facilitates the crystallization process.

In stretched crystalline rubber the crystals all have one axis pointing in a fixed direction. Viewed by X-rays, this kind of arrangement gives rise to a series of spots arranged in a characteristic pattern. This pattern bears a rather strong resemblance to the X-ray pattern of natural fibres (cotton, wool, etc.), and in fact, stretched crystalline rubber behaves mechanically like a fibrous material, as Hock showed in 1924. If stretched crystalline rubber is frozen in liquid air and hammered, it splits along the fibre axis, just like a piece of wood. Also, it is very easily torn along the direction of the grain, but is, of course, exceedingly tough in other directions.

The rubber crystal is birefringent, hence stretched rubber is highly doubly refracting. If a piece of vulcanized rubber is stretched between crossed 'Polaroid' plates, a succession of brilliant interference colours is developed as the extension increases, on retraction, the effect disappears. If the same is done with unvulcanized rubber, the effect does not disappear entirely on removal of the tension, in this case the crystals are more permanent. The

method may be employed for the quantitative study of crystallization in stretched rubber. Fig 4 shows the birefringence of raw rubber as a function of the elongation

The Synthetic Rubber GR-S

Before concluding, I should like to devote a few words to the consideration of the general purpose synthetic rubber GR-S now being produced in considerable quantities. This rubber, like the German 'Buna', is formed by polymerizing together butadiene and styrene. The chains are thus lacking in regularity (Fig 5), since these two components occur in a random order, with the result that crystallization is not possible. This probably accounts for the much lower tensile strength of GR-S vulcanizates which do not contain a reinforcing agent like carbon black, compared with similar natural rubber vulcanizates. Moreover, there would appear to be a possibility of the formation of branched chains (Fig 5b) leading to a cross-linked structure. It is suggested that this effect may account not only for the comparative difficulty encountered in milling it to a suitable softness, but also for its most unfortunate lack of self-adhesion. Self-adhesion involves a mutual diffusion at the surface of contact, any branching or cross-linking of the chains will considerably reduce such diffusion.

DIAGNOSIS OF MINERAL DEFICIENCIES IN CROP PLANTS*

By PROF T WALLACE

Long Ashton Research Station, Bristol

LIEBIG, in enunciating his mineral theory of the nutrition of crops in 1840, advanced the view that simple plant analysis would suffice to provide the data to determine the mineral requirements of crop plants and the amounts of mineral nutrients necessary to add to the soil to make good shortages due to removals by crops.

The field experiments of Lawes and Gilbert soon showed this conception to be erroneous and resulted in attention being focused on field trials and soil analysis as means of solving problems of crop nutrition, including deficiencies of mineral elements. From that time until 1920, these remained practically the only two methods in general use for determining deficiencies of mineral nutrients and the fertilizer needs of crops, and they still continue to play important parts in the solution of these problems.

Since 1920, however, other methods for diagnosing the mineral status of crop plants have been developed, based primarily on the plants themselves. In attacking problems in the field these methods are given complementary roles, and field trials and soil analysis are also included, with the result that problems are attacked from many angles and a choice of methods is available to suit the varied conditions which occur.

The new methods include visual diagnosis, foliage spraying, injection of leaves and stems, and chemical analysis of leaf laminae and petioles and of stems.

In practice it has been found that none of the methods used alone will provide a complete solution of deficiency problems in all circumstances, but when

used in complementary roles and with varied emphasis to suit different conditions, they have proved effective in solving very diverse and difficult problems.

Visual Symptoms of Mineral Deficiencies*

The visual symptoms which result from mineral deficiencies in crop plants have proved a valuable aid in diagnosis and form the basis of the visual method discussed later. In view of the importance of this method to technical agriculturists, it was considered worth while to devote one lecture entirely to the subject of deficiency symptoms.

Although the symptoms produced are very varied they allow of some classification and grouping. The deficiencies of nitrogen, phosphorus, potassium and magnesium always affect older tissues first, and the visual signs progress systematically from the older to the younger parts of the plants, whereas the deficiency effects of calcium, iron and boron invariably appear first in meristematic tissues and often result in the death of growing points.

In field crops in Great Britain, deficiencies of all the essential elements, with the exception of sulphur, copper, zinc and molybdenum, have been recorded and frequently occur, and it is thus of interest to summarize some of the main features of the deficiency effects which have been observed.

The effects produced by nitrogen deficiency are very consistent over a wide range of plants. Growth is greatly reduced, stems are upright and thin, and lateral shoots are few, leaves are small and usually pale green in colour, flowering and fruiting are much reduced, and autumn tints of leaves, stems and fruit are usually brilliant, consisting of yellow, orange, red and purple colours. Defoliation is premature.

Phosphorus deficiency produces many effects similar to those resulting from nitrogen deficiency but leaf symptoms are more variable. They may take the form of high colorations as for nitrogen deficiency but more often the tints are dull shades of purple, or tints may be absent altogether, the leaves remain a dull, lustreless, olive green, or the margins may become 'scorched'.

Potassium-deficient plants are generally squat in habit because of short stem internodes and, unlike deficiencies of nitrogen and phosphorus, lateral shoot may be abundant while shoots may die back. Marginal leaf scorch is a very common symptom, but leaves may also show tip scorch, chlorosis, spotting and backward or forward curling of the lamina. Bright tints are often lacking, though not invariably so.

Calcium deficiency results in the death of the growing points of shoots, which condition may lead to the development of adventitious laterals, and to the distortion, wilting and scorching of leaf margin, collapse of petioles and the death of flowers. Root growth is much restricted and tuber formation seriously affected.

Magnesium deficiency is remarkable for the diversity of leaf effects produced. These include chlorosis, brilliant tinting with well-defined colour pattern, interveinal necrosis (both central and marginal) and spotting. The effects produced are often highly spectacular and ornamental. Defoliation is generally serious and may follow very quickly after the appearance of leaf symptoms. Deficiency effects usually develop at a relatively late stage of growth.

* Summary of two lectures delivered at the Royal Institution on January 30 and February 6.

* For a full account and for illustrations of visual symptoms, see 'The Diagnosis of Mineral Deficiencies in Plants by Visual Symptoms' (with 1944 Supplement) by T. Wallace (H.M. Stationery Office) 15s.

Iron deficiency is characterized by chlorosis of the foliage, which develops first on the young leaves at the tips of shoots and later spreads to the older foliage. As the veins often remain green the chlorotic pattern may take several forms, such as mottling or striping, according to the venation of the leaf.

The effects of manganese deficiency vary considerably. Many plants show leaf chlorosis similar to iron deficiency, but others, like oats and peas, develop symptoms unlike those produced by any other deficiency. Thus oats show lesions of the leaf tissues—grey speck—and peas lesions in the flat surfaces of the cotyledons—marsh spot.

Boron deficiency effects are notable both for their diversity and severity. They result from abnormalities in the development of meristematic tissues. The effects for individual crops are often so striking that many have been given descriptive names by growers, for example, heart rot of sugar beet, brown curd and hollow stem of cauliflower, cracked stem of celery and brown heart of swede. The injuries produced may affect growing points, epidermis, vascular tissues or pith.

Visual Diagnosis

In its simplest form, visual diagnosis consists of a comparison of plants growing under conditions of mineral deficiencies with suitable standards of deficient plants, usually in the form of photographic records and detailed descriptions. In practice, wherever possible, use is made of 'indicator' plants. These are plants which show characteristic effects for particular deficiencies and on which the deficiency symptoms are readily recognized. Examples of such plants are oats as an indicator plant for manganese deficiency, sugar beet for boron and potato for potassium.

Where indicator plants are present in instances of deficiencies in the field, particular deficiencies can usually be identified by mere inspection of the visual symptoms, but where this is not possible other methods must be used either wholly or in a confirmatory role.

Where the cropping potentiality of land is unknown, as has frequently occurred in the breaking up of new areas for arable cropping during the War, the visual method may be employed on special indicator plots. These plots combine indicator plants as crops sown in strips, crossed with a number of manurial dressings, which arrangement results in all the crops growing under conditions of the presence and absence of each of the particular elements likely to be deficient. This scheme has proved effective in solving a number of difficult problems.

The visual method cannot be applied in instances where symptoms are masked or prevented from developing by attacks of certain insect pests and fungus diseases and by certain other factors.

In applying the method, it is often useful to make observations on certain soil characters, for example, pH, texture and drainage, and in all doubtful diagnoses confirmation must be sought in the complementary methods.

Foliage Spraying and Plant Injection

These two methods both aim at introducing mineral nutrients into plants through stems and leaves, and they may be used as alternative procedures according to convenience of application.

Plants under experimental conditions may be supplied with their entire requirements of mineral

nutrients, either major or trace elements, by means of foliage sprays, and in practice spraying is often more effective than soil applications for supplying trace elements, particularly for manganese and iron, which often cannot be given through the soil where deficiencies of these occur. Spraying methods are very simple. It is only necessary to know the correct strength of spray to use and the best time to spray. A watering can fitted with a rose is suitable for use on all ground crops, while for trees a pressure sprayer is required.

¹ In practice, for trace elements the solutions used contain 1–2 oz. trace element compound per 5 gallon applied to 30 sq. yd. and for trees 3 lb. per 100 gallon is a suitable concentration, major elements are usually only applied to ground crops, at strengths of 1–2 lb. per 5 gallon. Where the foliage is difficult to wet it may be necessary to add a wetting agent.

Spraying is especially valuable for use with the visual method. Results are generally evident 5–10 days after treatment.

Both solids and solutions are used for injections, the former being useful only where woody stems are available for treatment. Solid injections are especially valuable for iron deficiency, as applications of iron salts to the soil are usually ineffective and sprays often damage the foliage. The technique of solid injections is based on the method originally evolved by Bennett¹.

Roach, at East Malling, has been responsible for the methods of liquid injection in use. The injections are made on laminae and petioles of leaves and on stems, and methods have been developed for use on plants as widely different as cereals and trees². The periods required for responses from liquid injections are similar to those for sprays.

With injection methods the time and dosage factors are again important.

Chemical Methods

In applying methods of chemical analysis to plants as a diagnostic procedure due regard is paid to established principles of plant physiology. The plant parts used comprise leaf laminae, petioles and stems, as representing parts of the plants which reflect most accurately their mineral status. It is usual either to compare the status of mineral nutrients of healthy and unhealthy plants growing in close proximity or to make comparisons with standards fixed from previous experience. In this latter connexion it has been found possible, when sampling methods are standardized, to fix 'threshold' values for the various elements in particular plants below which deficiencies may be expected. The chemical data are generally computed on a basis of dry matter.

In selecting material for analysis, samples must be comparable from the physiological point of view, otherwise growth and seasonal cycles may render comparisons invalid.

During recent years, methods for carrying out rapid chemical tests on plant tissues, suitable for use either in the field or laboratory, have been introduced³, which have proved useful in indicating deficiencies and in confirming the results of other methods.

The development of spectrographic and polarographic methods has also speeded up routine analytical procedures and made possible the detection of unusual elements giving rise to new problems.

A special technique for chemical diagnosis has been developed by Lagatu and Maume⁴ in France and by

Thomas and Mack⁵ in the United States, which has been designated 'foliar diagnosis'. The method compares the nutrient status of test plants with that of healthy, heavy-cropping plants, regard being paid to seasonal cycles of nutrients and to quantitative and qualitative aspects. The 'method' is, of necessity, somewhat slow for general advisory purposes.

Chemical methods, however, are not infallible and if used alone may fail to provide the correct solution to certain problems. This is particularly so in instances of iron deficiency, where the element apparently becomes immobilized within the plant tissues from a variety of causes, as in lime-induced chlorosis, some instances of potassium deficiency and in the presence of toxic concentrations of other elements.

Soil Analysis and Field Trials

During the course of long usage, these methods have undergone considerable elaboration, soil analysis chiefly by the development of methods of determining 'available' nutrients⁶ and by the introduction of rapid methods⁷, and field trials by the development of designs allowing of statistical analysis⁸.

The data provided by soil analyses can be of great value when used by an expert and supported by previous field experience, but they must be regarded only as pointers to probable mineral deficiencies since the intake of minerals by plants is not determined solely by chemical supplies in the soil. The method is chiefly of use for phosphorus and potassium deficiencies, and in providing data relating to acidity and organic matter.

As the response of the crop to a nutrient element, however the response may be obtained, must always be regarded as a final test of a deficiency of a particular element, field trials must always be of importance in diagnosis. But even here erroneous conclusions may be drawn, particularly so where trace element deficiencies may be remedied by changes in the pH of the soil. Thus, applications of sulphur to the soil may remedy a deficiency of manganese and alleviate deficiencies of iron and boron by lowering the pH, and conversely the application of lime may cure a deficiency of molybdenum. Moreover, soil dressings of manganese and iron salts are ineffective in many soils against these deficiencies, which nevertheless may be quickly and completely remedied by spraying or injection treatments.

The usual field trial methods may also be too slow in producing results for advisory purposes, as for example, for deficiencies of potassium and magnesium of fruit trees.

Experience with mineral deficiencies of crops in the field has shown that the problems may be very complicated and that no one method can be relied upon to provide a general solution. The most effective procedure is to use all available methods of attack in a complementary way, and in doing so, full use should be made of all the data which the plants themselves provide.

¹ Bennett, J. P., Univ. California Agric. Expt. Stat., Circ. 321 (1931).

² Roach, W. A., Imp. Bur. Hort. and Plant Crops Tech. Comm. 10 (1938).

³ Thornton, S. F., Conner, S. D., and Fraser, R., Purdue Univ. Agric. Expt. Stat. Circ. 204 (Revised) (1939).

⁴ Lagatu, H., and Maume, L., *Ann. l'école nationale d'agric., Montpellier*, N. S., 22, 4, 257 (1924-33).

⁵ Thomas, W., and Mack, W. B., Penn. State Coll. Bull. 378 (1939).

⁶ Stewart, R., Imp. Bur. Soil Sci. Tech. Comm. 25 (1932).

⁷ Morgan, M. F., Conn. Agric. Expt. Stat., Circular 127 (1939).

⁸ Crowther, E. M., *J. Roy. Agric. Soc.*, 97 (1936).

OBITUARIES

Sir Hanns Vischer, C.M.G., C.B.E.

THE death on February 19 of Hanns Vischer has removed a notable and commanding figure from the sphere of African interests. Even his entry, more than forty years ago, into the political service of Northern Nigeria was in itself a notable event, for by birth he was a foreigner and his previous contact with Africa had been in the mission field, neither of which circumstances could in those early days be regarded as an 'open sesame' to the British Colonial Service. But there was that in Vischer's make-up before which all prejudice, British or African, melted like snow in the midday sun, and the reason was not far to seek. The Hausa people, quick at all times to detect the idiosyncrasies of their alien overlords, proclaimed the secret of his influence in two words. Throughout the country he was known as Dan Hausa ('Son of Hausa')—perhaps the most significant nickname ever conferred on a European in West Africa. It meant that in him the Hausas recognized, not only a man who possessed an extraordinary command of their delightful and expressive language, but also one whose affection for them was equalled by his insight into the innermost recesses of the African soul. It meant that they had, as it were, adopted him. One had only to watch him in his daily avocations in those early days to realize how completely at home he was with every class of society—whether he was engaged in grave deliberations with emirs, viziers and other high personages of the ruling hierarchy, or whether he was chaffing the hucksters at the market stalls as he rode through Kano city. No less revealing was it to see him in his own home pick up a native drum and, squatting on the floor, croon local Hausa songs to his own accompaniment. So imitatively did he do it that, if he had been hidden behind a screen, one would have said that an African musician had been engaged to entertain his guests.

No one who knew Kano in the years before the War of 1914-18 will ever forget the spirit of the motley community over which Hanns and Isabelle Vischer presided at the headquarters of the Education Department at Nassarawa. Isabelle's influence was second only to her husband's. If Hanns had it all his own way with the men, it was to Isabelle that the women laid bare their joys, their absurdities and their sorrows. She was the true *uwargida*, the mother as Hanns was the father, of the great family.

It need scarcely be said how firmly Hanns and his wife were established in the affections of their British colleagues. Those—and they are now a much diminished band—who enjoyed their hospitality at Nassarawa before the War of 1914-18 will long remember the charm and gaiety of evenings spent in their company. Indeed, as one looks back, they, more than any two other people, seemed to embody the spirit that pervaded the Northern Nigeria Service in those early days—the light-heartedness, the good fellowship, the sport and, above all, the eager and adventurous interest in the problems of a fascinating and newly opened country.

Lack of space forbids me to speak of Hanns Vischer's later career, of his military service in the War of 1914-18 and of the widespread influence which he exercised as secretary of the Advisory Committee on Education at the Colonial Office and as secretary general of the International Institute of African Languages and Cultures. In these larger spheres his

great achievements have been widely known and acclaimed. If I have dwelt on the remote and less well-known period of his life in Northern Nigeria, it is because at that time the foundations of his future influence were laid—an influence which sprang from his passionate devotion to the people of Africa and the reciprocal devotion to him of the Africans whom he served so well. G J F TOMLINSON

Mr. Thomas Sheppard

WITH the passing of Mr. Thomas Sheppard at his home in Hull on February 18, the city has lost a notable character. Though officially the director of the Hull Museums for forty years (until his retirement in 1941), his activities ranged over a wide field, from organizing exhibitions directing attention to Hull's trade and commerce, and lecturing up and down the country on a variety of subjects, to contributing numerous articles to the Press.

As showing his diversity of interests, Sheppard was a past president of the Museums Association, the Yorkshire Geological Society, Hull Scientific and Field Naturalists' Club, Hull Geological Society, Hull Literary Club, Yorkshire Numismatic Society, Hull Publicity Club, Hull Luncheon Club, and the Hull Playgoers' Society, and a past chairman of the Conference of Delegates of Corresponding Societies of the British Association. He was also a member of the Hull University College Historical Committee, Hull Development Committee, and the Yorkshire Roman Antiquities Committee, and was local secretary when the British Association visited Hull in 1922. He issued two hundred Publications of the Hull Museums, edited the *Naturalist* for thirty years and was also responsible for the bibliographies of Yorkshire geology, and Mortimer's "Forty Years Researches".

Perhaps Sheppard's most important work was in connexion with geology, and he received the Lyell Award of the Geological Society of London for his contributions to this subject. In recognition of his scientific work, he received the honorary degree of master of science from the University of Leeds and he was made an associate of the Linnean Society.

During his long service as director of the museums of Hull, the Albion Street Museum, Wilberforce

House, the Natural History Museum, Museum of Fisheries and Shipping, the Museum of Commerce and Transport, Mortimer Museum of Prehistoric Archaeology, and the Railway Museum at Paragon Station were opened. In fact, he gained a well-known reputation of having very few scruples when it came to obtaining exhibits for his beloved museums.

A man of genial personality and a great sense of humour, he had been in failing health for some years, and the fact that his work was done, and the results of so many years of interest destroyed during the air raids on the city of Hull, contributed greatly to his death at the age of sixty-eight. J B FAX

Dr. E. C. Wiersma

ACCORDING to a brief announcement in *Die Chemist* of October 28, 1944, Dr. E. C. Wiersma died at Delft at the age of forty-two. He was known for his work at the Kamerlingh Onnes Low Temperature Research Laboratories at Leyden. Both independently and in collaboration with Dr. W. J. de Haas, Wiersma had published a number of papers on the influence of low temperatures on the paramagnetism of certain metals and salts. He studied the adiabatic cooling of magnetic bodies and the production of low temperatures by adiabatic demagnetization. In 1931 he published a classification of para-magnetic atoms, molecules and ions based upon their fields at low temperatures. He also deduced a thermodynamic scale for temperatures below 1° Abs.

WE regret to announce the following deaths.

Sir James Barrett, K.B.E., C.M.G., sometime vice-chancellor and later chancellor of the University of Melbourne, and a founder and original fellow of the Royal Australian College of Surgeons, aged eighty-three.

Engineer Vice-Admiral Sir George Goodwin, K.C.B., formerly engineer-in-chief of the Fleet and a past-president of the Institute of Metals and of the Institute of Marine Engineers, on April 2, aged eighty-two.

Dr. G. L. Taylor, of the Galton Laboratory Serum Unit, recently seconded to the Medical Research Council, aged forty-seven.

NEWS and VIEWS

Bessemer Gold Medal: Award to Mr. Harold Wright

MR. HAROLD WRIGHT, chief metallurgist to Dorman Long and Co., Ltd., Middlesbrough, has been awarded the Bessemer Gold Medal by the Iron and Steel Institute in recognition of his "valuable contributions made over many years to improve the technique of iron and steel manufacture". The Medal, which is the highest award conferred by the Institute, will be presented to Mr. Wright by the president, Mr. Arthur Dorman, at the annual meeting of the Iron and Steel Institute in London on May 9. Mr. Harold Wright has been a member of the Institute since 1902 and has served on its Council; he is a past president of the Cleveland Scientific and Technical Institution and of the Cleveland Institution of Engineers. He started work at the North Eastern Steel Works. While with Sir Bernard Samuelson, Mr. Wright took an

active part in the supply of molten basic iron to Dorman Long's Britannia Works when the latter firm introduced the hot metal process forty years ago. While in charge of the Newport coke ovens, Mr. Wright promoted the use of coke oven gas for town purposes. He first made the suggestion in 1902, but it was 1913 when the supply was first established. Mr. Harold Wright also possesses considerable geological knowledge, and has done a great deal of exploration work in connexion with the Cleveland ironstone deposits. He was also responsible for the introduction into local blast furnace practice of the use of rich foreign ores in the Cleveland burden. Mr. Harold Wright was appointed chief metallurgist to Dorman Long and Co., Ltd., in 1918. Last December the Company inaugurated a triennial Harold Wright Lecture to be given before the Cleveland Scientific and Technical Institution in recognition of his long and valuable service.

Dr. F. C. Steward

DR F C STEWARD, reader in plant physiology in Birkbeck College, University of London, has recently left for the United States to take up a temporary appointment as research associate in the University of Chicago, where he is to develop certain aspects of plant physiology and biochemistry in which Prof E J Kraus and the Chicago Department of Botany are interested. Dr Steward has been given leave of absence by Birkbeck College for this purpose, and the appointment is a sequel to the destruction in an air raid of the research laboratory in plant physiology at Birkbeck, which had been largely equipped by the Rockefeller Foundation. Dr Steward has been engaged since 1941 with the Ministry of Aircraft Production, where he developed a department dealing with statistics concerning the determination and forecasting of Royal Air Force requirements. It seemed that his return to botanical research would be delayed indefinitely by the destruction of his laboratory, so that the offer of Prof Kraus has rendered a real service to botanical inquiry.

Mrs. Neville-Rolfe, O.B.E.

MRS NEVILLE-ROLFE has resigned her office as honorary secretary of the British Social Hygiene Council. Fortunately this does not mean a severance of her interest in the Council. She has been elected a vice-president, and has also accepted a new office of honorary adviser, which will enable her to place at its disposal her great store of accumulated knowledge and experience. As honorary secretary of the National Council for Combating Venereal Disease from its foundation thirty years ago, she took the principal part in organizing the whole scheme of popular education in this subject—one hitherto taboo. In these early days the work of popular enlightenment on venereal disease was financed by a direct grant from the Exchequer, but the difficulty lay in persuading local authorities to avail themselves of the educational material offered by the Council, and in overcoming the resistance of many hospital authorities to the establishment of free clinics. In this work, and also in the organization of lectures to the armed forces during the War of 1914-18, Mrs Neville-Rolfe was indefatigable.

As the years passed, it became increasingly obvious that the problem of venereal disease was only one aspect of a larger one, that of social hygiene in its wide sense, and that the Council's work should cover this wider field so as to combat the causes leading to sexual misconduct—the absence of biological teaching of the adolescent, the lack of training of teachers and instruction of parents, and the need for amelioration of various relevant social malconditions. At the same time, the name was changed to British Social Hygiene Council, and Mrs Neville-Rolfe organized the wider field with undiminished zeal. In addition, however, to this work on the home front, she was able to extend its scope to the Dominions and the Colonies, in many of which branches and colleague organizations were established. Through the collaboration of the Government Departments concerned, several overseas visits and commissions were arranged and carried out by the Council between the years 1920 and 1936. Mrs Neville-Rolfe, in 1926, spent six months in India, touring many provinces and States on the invitation of their respective Governments. She also, at various times, visited Canada, the Far East, Palestine, Cyprus, Jamaica

and Southern Rhodesia, investigating local conditions and organizing measures for reducing the incidence of venereal disease. Liaison was also established internationally with the various foreign societies working in this field, and she was one of the founders of the Union Internationale Contre le Pêril Vénérien, holding office as vice-president, and chairman of its Ports Commission. In 1941, she was awarded the Snow Gold Medal of the American Social Hygiene Council for work in social hygiene (*Nature*, 147, 261, 1941).

Chemical Technology at Imperial College

THE Imperial College of Science and Technology, with the approval of the Court of the University of London, has lately accepted from Messrs Courtaulds, Ltd, a benefaction intended to promote its work in the field of chemical technology. This benefaction, which is calculated to yield an income of £3,000 per annum in perpetuity, will be administered for the present by a small body of trustees, and will permit the institution in Imperial College of a Courtaulds chair of chemical engineering, to which it is expected that an appointment will be made this year. It will also provide for other needs in the Department of Chemical Technology, in ways that will be decided by the trustees after consultation with the College. The Governing Body of Imperial College has recorded their most grateful appreciation of the gift, which is an outstanding event of this centenary year.

Visits of French and Belgian Medical and Scientific Workers

A FRENCH medical delegation of ten is visiting Great Britain during April 7-17 as guests of the British Council, in conjunction with the Royal College of Physicians, and will be entertained by other organizations, including the Royal Society of Medicine. The delegation will see hospitals in London and elsewhere and visit Oxford and Cambridge. The members are Académie de Médecine Prof Baudouin, dean of the Faculty of Medicine, Paris, Prof A Lemierre and Dr P F Armand-Delille, Conseil Supérieur de Médecine. Dr Ravina, Dr A Laporte and Dr H Descomps, Provinces. Prof C Soula (Toulouse), Prof Gernez-Rieux (Lille), Prof Roche (Marseilles) and Dr Nedelec (Angers). The first of four groups of representatives from Belgian universities, whose visits are being arranged by the Belgian Fondation Universitaire, will be in Britain during April 16-30. The other groups will follow at intervals between May and July. The members of the first group are Prof V Bohet, professor of English, Liège, Prof N Goormachtigh, Faculty of Medicine, Ghent, Prof P Govaerts, Faculty of Medicine, Brussels, Prof M F L Hemptinne, Faculty of Science, Louvain, Prof C J Jungers, Faculty of Science, Louvain.

Bibliography of the British Flora

WITH the view of eventual publication, it is proposed to compile a bibliography of the British Flora. One section of this, on local botany, would comprise all publications, which it is possible to trace, dealing wholly or partly with the flora of any area within the British Isles. This section would include local floras and works on topographical botany, and all publications, such as local and county histories, guide books, periodicals and newspapers, etc, in which plant lists of particular areas have appeared, manu-

scripts of 'sufficient importance and authenticity would also be listed. Where, however, only incidental mention is made of plant localities, as in many of the standard floras of Britain and in monographs, these would be omitted from this section.' The compilation will entail a large amount of research and will be possible only with the co-operation of helpers who have the requisite local knowledge of the literature of their areas. The editors are Mr J. S. L. Gilmour, Mr H. A. Hyde, Mr H. S. Marshall, Mr N. Douglas Simpson and Dr G. Taylor. Those willing to help in this compilation should communicate with Mr N. Douglas Simpson, Maesbury, 3 Cavendish Road, Bournemouth, Hants, indicating when they can begin work, in what areas they are interested and to what libraries and periodicals they have access.

Early Scottish Prehistory

It is doubtful whether it can be proved that any cultures earlier than the Mesolithic existed in Scotland. This is perhaps surprising, as there would seem to have been no climatic reason why Scotland should not have been habitable during the main interglacial epoch in the middle of the Great Ice Age in any event. Maybe the scanty populations of the Old Stone Age never reached the extreme north-western edge of the Old World. Mesolithic industries contemporary with those farther south have been unearthed at a number of sites. But many of the apparently Mesolithic industries in Scotland are actually much more recent in date and contemporary with the Neolithic or even early Metal Age farther south. Even in the Cleveland hills of Yorkshire, sites are known where pigmy tools of Mesolithic facies occur in real association with leaf-shaped arrowheads. Such an overlap of cultures is not surprising. The Neolithic civilization in Britain was rather due to the coming of new modes of life than to hordes of invaders, in large part it was a case of 'neolithizing' the autochthonous inhabitants. Off the beaten track, the older culture continued to survive, influenced to a greater or less degree by the more advanced ideas spreading slowly over the land.

Much of our information of these early cultures in Scotland is due to the work of A. D. Lacaille, who is collecting a corpus of material for eventual publication after the War. Recently, he gave a paper to the Society of Antiquaries of Scotland on the stone industries associated with the raised beach at Ballantrae. The sites are in Wigtownshire and south Ayrshire, and the specimens were collected on the tilled surface of the raised beach, which itself dates to the period of the Littorina Marine transgression. With the specimens of Mesolithic facies were found others, Neolithic in appearance. The evidence would seem to point to the introduction there of the Neolithic civilization towards the end of the Atlantic post-glacial phase. Among the Mesolithic types of implements occur specimens which recall some found in northern Irish sites. Thus tanged points resembling those from the valley of the River Bann have been found. Mr Lacaille's definitive publication will be awaited with interest. There is still a lot to be learnt about the cultural overlaps in Scotland and the various influences that went to form the earliest Stone Age cultures north of the Cheviots.

Archæological Expedition to Mexico

THE War has forced the National Geographic Society to curtail its scientific field expeditions, but the archæological studies that have been made

annually since 1937-38 in southern Mexico under the sponsorship of the Society and the Smithsonian Institution will continue. The seventh expedition, headed by Dr. Matthew W. Stirling, is on its way to the southernmost Mexican State of Chiapas where, digging into huge burial mounds and clearing dense jungle growth, he will continue to reveal some of the secrets of pre-Columbian civilization in this hemisphere. Dr. Stirling is accompanied by his wife, Marion Stirling, who is also an archæologist, and Richard H. Stewart, staff photographer of the National Geographic Society. The expedition this year plans to conduct its studies in the mountains east of the Isthmus of Tehuantepec.

Social Implications of Engineering

ON March 28, Sir Harry Railing, president of the Institution of Electrical Engineers, delivered an address to the London Students' Section of the Institution, taking as his subject the social implications of engineering. Sir Harry stressed that it is essential for the engineer to grasp the inner meaning of his work and the mission he has to fulfil in his everyday life. To do this, a full appreciation of past achievements is necessary, and he must feel that, however small or large his contribution, he is a vital unit in a powerful living force. Material progress has been so remarkable that too little attention has been paid to the development of the lives of human beings. Humanity should have been trained and encouraged to accommodate itself to the increased impetus of science and engineering, so as to avoid a disastrous piling up of pent-up energy. Engineers should have foreseen these consequences more clearly and made the world realize that increasing material knowledge necessitates the acceptance of new responsibilities both on the part of the individual, the community and the State.

Sir Harry Railing does not believe in early specialization. When specialization becomes necessary, engineers should retain a broad understanding of the work of others in as wide a field as possible. Of the relative value of the methods most useful in engineering work, mathematics and physics are of paramount importance. But engineering involves also the handling of human beings, and it vitally affects their lives. A broader understanding of sociological problems is necessary, and if the engineer's work neglects the spiritual aspect it is liable to be a dismal failure. For the well-being of the community the scientific approach should be applied to social problems and politics, but its limitation should be borne in mind. Man is finite, not infinite, and from this should spring humility and tolerance of others.

Jubilee of the *Astrophysical Journal*

WITH the current issue of the *Astrophysical Journal*, this periodical completes its hundredth volume. Founded in 1895 by Hale as an international review of spectroscopy and astronomical physics, the *Astrophysical Journal* soon became the acknowledged medium for the publication of research, and especially of observational research, by English-speaking astrophysicists. Although the original plan of appointing collaborating editors from countries other than the United States has been recently abandoned, the international character of the journal is still attested by its contents pages. During the past fifty years such famous names as those of Cornu, Huggins, Belopolsky, Kayser, Schuster, Newall and Alfred Fowler have appeared beside those of their American colleagues,

and such contemporary names as Adams, Millikan, Russell, Shapley and Otto Struve are likely to be as well remembered in the future. Nearly all the major spectroscopic and astrophysical advances of the past half-century are recorded in the first hundred volumes—the Fabry-Perot interferometer, the Rowland solar wave-length table, the first photographic trigonometrical parallaxes and spectroscopic parallaxes, the 100-in telescope, the Einstein and the nebular red-shifts, 'nebulum' and super-novæ, to mention only a few. With the completion of the 200-in telescope after the War, science may look to see its boundaries enlarged yet again in the pages of the *Astrophysical Journal*.

Temperature Compensation in Instruments

A PAPER read recently in London by Dr G F Tagg before the Institution of Electrical Engineers has for its theme the fact that one cause of errors in indicating and recording instruments is their use at a temperature other than that at which they were calibrated. Most of the physical properties of materials on which instrument performance depends vary to a greater or less degree with temperature. It is therefore necessary when designing an instrument to reduce to a minimum any errors caused by changes in temperature, and if possible to make them negligibly small. This is done either by adopting a design such that the temperature errors themselves are very small, or by introducing other changes with temperature which will compensate them. An account is given in the paper of the more common methods employed, each method being briefly discussed to indicate the best arrangement for each type of instrument. The instruments considered are ammeters, voltmeters, millivoltmeters, wattmeters and rectifier-operated and thermocouple instruments.

Recent Earthquakes

DURING the third quarter of 1944, fifty-eight earthquakes and tremors were recorded at Toledo, Spain, while during the same quarter twenty-six strong earthquakes were recorded at the Dominion Observatory, Wellington, New Zealand. The earthquake of October 29 was felt with Scale 5 (modified Mercalli) in the southern parts of North Island and Taumarunui, the shock of November 25 was felt at Karama with Scale 4 and that of December 24 was felt at Timaru with Scale 3 intensity. The United States Coast and Geodetic Survey determined the epicentres of several shocks which occurred during the quarter. On October 23 the epicentre was in Ecuador, South America, on December 7 (lat 33° N, long 137° E) off Japan, on December 10 in the New Hebrides Islands and on December 12 in the Aleutian Islands.

The Ray Society

At the annual general meeting of the Ray Society held on March 22, Mr A D Cotton, president of the Linnean Society, was elected a vice-president and Prof F Balfour-Browne, Dr W S Bristowe and Dr John Smart new members of Council. It was announced that Dr F E Zeuner's volume on "The Pleistocene Period" would soon be ready for distribution, and that Dr Dawes's work on "The Trematode Parasites of British Fishes" was nearly ready for printing. Owing to the increase in costs, Dr Zeuner's book will form the issue to subscribers for the two years 1942 and 1943, and it is intended that Dr Dawes's volume shall be issued for the year 1944.

Other works are in preparation, but no dates can yet be announced for their probable publication.

Oliver Lodge Scholarship

IN order to commemorate the silver jubilee of the Radio Section of the Institution of Electrical Engineers the Council of the Institution has founded a research scholarship which is to be called the Oliver Lodge Scholarship. It will have a basic annual value of £250 and will be tenable for one year, but may be extended for a second year. The Council wishes to encourage scholars to travel and, after approval of a candidate's programme, may make an additional grant for this purpose. The scholar will be required to carry out research in a subject closely allied to radio engineering. Further particulars and nomination forms can be obtained from the Secretary, Institution of Electrical Engineers, Savoy Place, Victoria Embankment, London, W C 2. The closing date for receiving nominations is May 15, 1945.

Announcements

THE following have been elected by the Governing Body to honorary fellowship of the Imperial College of Science and Technology: the Most Hon the Marquess of Crewe, Mr C S Garland, Mr Percy Good, Dr Andrew McCance, the Right Hon Lord Rayleigh, Prof J S Truscott, Lieut-General Sir Pierre Van Ryneveld, Prof W W Watts, Prof A N Whitehead and Dr H E Wimperis.

MR O S PUCKLE, recently of the Research Department of Messrs A C Cossor, Ltd, has been appointed chief engineer of R F Equipment, Ltd, Plantation Road, Amersham, Bucks, with a seat on the board. In particular he will be responsible for research and development.

THE posts of inspector-general of forests to the Government of India and president of the Forest Research Institute and Colleges have been separated. A separate post of president of the Forest Research Institute and Colleges, Dehra Dun, has been created, this post is being filled by Mr C E Simmons. The inspector-general of forests (Sir Herbert Howard), with his office and staff, has been transferred to New Delhi. His address in New Delhi will be "Inspector-General of Forests, Department of Education, Health and Lands, New Delhi", and his telegraphic address will be 'Igforest, New Delhi'. All correspondence connected with research and education at Dehra Dun should be addressed to the President, Forest Research Institute and Colleges.

TRINITY COLLEGE, Cambridge, has decided to resume in the present year the annual offer of a research studentship which has been suspended since 1941. The studentship is open to graduates of other universities who propose to go to Cambridge as candidates for the degree of Ph D, provided that on June 1, 1945, they have not commenced residence in the University of Cambridge and are not more than twenty-six years of age. In computing the age of a candidate for this purpose, any days of war service will be deducted from his actual age. Candidates should apply through the principal authority of their university, and applications should reach the Senior Tutor of Trinity College (from whom further particulars may be obtained) before June 1, 1945.

LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications.

Adhesion of Lubricated Metals

It is evident, both from an examination of the contours of solid surfaces, and from measurements of the electrical conductivity between metals¹, that the real area of contact between two surfaces is only a small fraction of the apparent area of contact. This means that even with quite small loads very large pressures will be developed at the few points of real contact. It has been shown that these pressures are sufficient to cause local adhesion and welding of the surfaces at the points of contact, and that the tangential force required to shear the junctions is a major component of the friction between sliding metals².

The reality of this metallic welding may be demonstrated by a microscopic examination of sections of the track, and an example of this is given in Fig. 1. A curved copper slider was allowed to slide once (at low speed, 0.01 cm. per sec.) over a mild steel surface. The load was 4,000 gm. and the experiment was done both with clean and with lubricated surfaces. When the surfaces were clean, the coefficient of friction was high ($\mu = 0.6-0.7$) and many tiny particles of copper were left adhering to the steel. Fig. 1 is a photomicrograph of a taper section of one of these particles. It was made by protecting the steel surface with an electro-deposit and cutting a section at a very oblique angle so that the magnification of the vertical component of the surface contour was ten times that of the horizontal component. A modification of the technique described by Nelson³ was used. In this photograph the vertical magnification is 5,000 and the horizontal 500. It will be seen that the copper is welded firmly on to the steel, and the shearing of the copper has caused a plucking up of the steel above the general level of the surface. This would lead to a wearing away of the

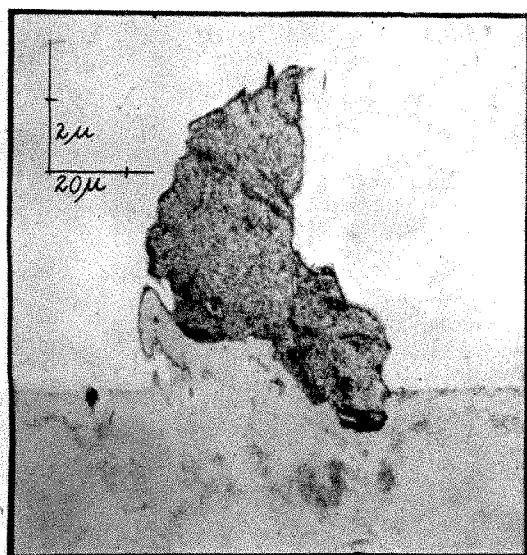


FIG. 1. TAPER SECTION SHOWING COPPER FRAGMENT (DARK) WELDED ON TO STEEL SURFACE; NOTE PLUCKING UP OF STEEL. VERTICAL, $\times 5000$; HORIZONTAL, $\times 500$.

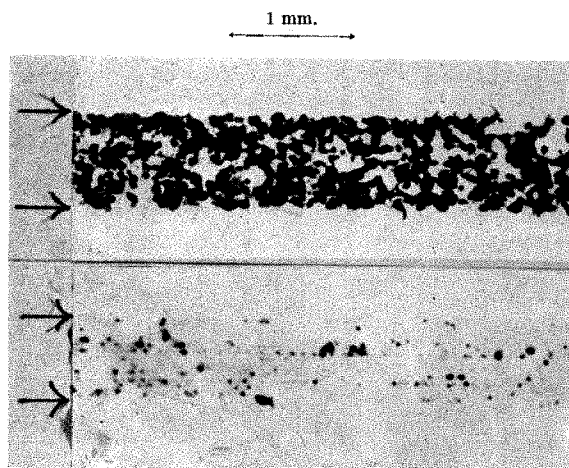


FIG. 2. CHEMICALLY DEVELOPED TRACK OF COPPER SLIDER ON A CLEAN (ABOVE) AND LUBRICATED (BELOW) FLAT STEEL SURFACE. THE TRACK LIES BETWEEN THE ARROWS, WHICH SHOW DIRECTION OF SLIDING. BLACK AREAS ARE COPPER. $\times 11$.

steel, and shows graphically how a hard metal can be worn by a soft one.

When the metals are lubricated, the friction falls to about $\mu = 0.15$. The earlier frictional and conductivity experiments have shown that metallic contact and adhesion still occur through the lubricant film, but they are, of course, greatly reduced and difficult to detect by the taper section method. The existence of this localized adhesion and its distribution over the surface of the track may, however, be revealed by a chemical technique using a method similar to that described by Hunter, Churchill and Mears⁴ for the detection of metallic inclusions. A gelatine-coated paper which has been immersed in a suitable electrolyte is placed on the surface of the metal to be examined and a current passed so that the foreign metal is electro-dissolved into the gelatine. If an appropriate reagent is present in the gelatine, very small quantities of metal may be detected. In this case dithio-oxamide was used to detect copper, and Fig. 2 shows the patterns obtained by allowing the copper slider to pass once over polished steel (a) when clean and (b) when lubricated with 1 per cent lauric acid in paraffin. The black areas indicate copper, and it will be seen that the adhesion of copper to the lubricated steel surface is quite considerable. The track of the slider is about 1 mm. wide, and adhesion has occurred at a number of small points distributed over it. There is a tendency for these points to lie on straight lines in the direction of sliding, and this probably corresponds to high spots on the copper slider.

Similar experiments of a more quantitative nature were carried out with copper on platinum, both clean and lubricated with solid potassium stearate. Any copper adhering to the flat platinum surface after the copper slider had passed over it once was removed electrolytically from an appropriate length of track and micro-estimations made with sodium diethyl dithiocarbamate. With the clean metals the friction was high and irregular ($\mu \sim 1.8$) and the surface density of copper adhering to the platinum was 2×10^{-5} gm. per mm.² of track. With lubricated metals the amount of copper adhering to the platinum was 1.7×10^{-7} gm./mm.². If this copper were spread evenly over the platinum in the path of the slider, it would correspond to a layer about fifty atoms thick; but as the photographs show, it is distributed

irregularly over the surface of the track in a number of small discrete particles of varying size.

In a recent interesting paper, Sackmann, Burwell and Irvine⁵ describe the application of a radioactive method to the measurement of the pick-up of metals. Their results are not directly comparable with ours since they measure the amount of metal which accumulates on the small curved surface of the slider after it has traversed a certain distance; but again the results confirm the observation that metallic adhesion occurs through the lubricant film.

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Dec. 1.

¹ Bowden and Tabor, *Proc. Roy. Soc., A*, **169**, 391 (1939).

² Bowden, Moore and Tabor, *J. Appl. Phys.*, **14**, 80 (1943).

³ Nelson, Conference on Friction and Surface Finish, Mass. Inst. Tech., 217 (1940).

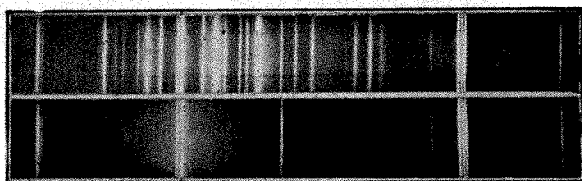
⁴ Hunter, Churchill and Mears, *Met. Prog.*, **42**, 1070 (1942).

⁵ Sackmann, Burwell and Irvine, *J. Appl. Phys.*, **15**, 459 (1944).

Raman Spectrum of Quartz

SINCE quartz is transparent in the ultra-violet, the employment of the powerful technique for Raman-effect studies developed by Rasetti, in which the 2537 Å. radiation from a water-cooled magnet-controlled mercury arc is the exciter, naturally suggests itself for this crystal. Rasetti's own studies¹ included quartz, but his exposures were very short (20 min.) and it is therefore not surprising that he recorded only fourteen distinct frequency shifts as against the twenty shifts found earlier by Gross and Romanova² with the 4358 Å. radiation of the mercury arc as the exciter and exposures of the order of 120 hours. However, by prolonging the exposure with the Rasetti technique to 48 hours for a crystal 15 cm. long, I have recorded a very intense spectrum reproduced herewith, in which no fewer than forty-one distinct frequency shifts have been observed and measured. All the twenty-one newly observed frequency shifts are represented by relatively feeble lines and evidently belong to the Raman spectrum of the second order, namely, octaves and combinations of the fundamental frequencies of the quartz lattice. The accompanying table gives the measured frequency shifts in wave-numbers, the relative intensities of the lines being roughly indicated on an arbitrary scale within brackets.

Frequency shift and strength	Assignment	Frequency shift and strength	Assignment
127 (20)	E_1	859 (1)	
145 (2)		890 (1)	$B_2 + E_3$
207 (15)	A_1	925 (1)	$E_1 + E_3$
267 (7)	E_2	940 (1)	$2A_2, 2B_2$
319 (1)		960 (1)	
358 (6)	A_2	1033 (1)	
395 (5)	$E_1 + E_2$	1065 (4)	E_4
404 (5)	E_3	1082 (3)	A_4
453 (2)		1134 (1)	
467 (30)	A_3	1160 (7)	E_7
480 (2)	(B_2)	1228 (3)	E_8
500 (2)		1248 (1)	
520 (1)	$E_1 + E_3, 2E_2$	1276 (0)	$A_1 + E_4$
546 (1)		1369 (0)	$A_1 + E_7$
585 (1)	$A_1 + B_1$	1381 (0)	
645 (1)		1429 (0)	$E_2 + E_7$
670 (0)	$E_2 + E_3$	1456 (0)	$B_4 + E_3$
696 (4)	E_4	1570 (0)	$B_1 + B_4$
727 (0)	$A_2 + E_2$	1610 (1)	$2B_3, A_3 + E_7$
794 (5)	E_5	1630 (1)	
805 (5)	$2E_3, (B_2)$	2379 (1)	$2B_4$
834 (1)		2430 (1)	



ABOVE, RAMAN SPECTRUM OF QUARTZ. BELOW, COMPARISON SPECTRUM OF MERCURY ARC.

According to Bishambar Dayal Saksena³, the group of three silicon and six oxygen atoms present in the unit hexagonal cell of the quartz lattice has sixteen distinct fundamental modes of vibration, four of the A class active only in Raman effect, four of the B class active only in infra-red and eight of the E class active in both. The fundamentals shown as such in the table are distinguished by their relatively large intensities, and those of the A class by the strong polarization of the lines. The four fundamental frequencies coming under the B class have been assumed from the infra-red measurements of Plyler⁴ as $B_1 = 385$, $B_2 = 488$, $B_3 = 800$ and $B_4 = 1,190$ wave-numbers. The identifications of some of the weaker lines as overtones and allowed combinations are shown in the table, but are only provisional.

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¹ Rasetti, F., *Nuovo Cimento*, **9**, 72 (1932).

² Gross and Romanova, *Z. Phys.*, **55**, 744 (1929).

³ Bishambar Dayal Saksena, *Proc. Ind. Acad. Sci.*, **A**, **12**, 93 (1940).

⁴ Plyler, *Phys. Rev.*, **33**, 48 (1929).

Absorption Spectra of Mercury Halides

RAO¹ has recently observed the absorption spectra obtained when halides of mercury were placed in a heated steel tube. New systems attributed to HgCl and HgBr were found and analysed, leading to values for the dissociation energies of these molecules. Comparison of the wave-lengths of these 'new' bands with tables² of collected band heads of known molecules reveals coincidences with CuCl and CuBr. More detailed comparison shows that Rao's Q_1 heads of 'HgCl' coincide with the D system of CuCl, and the Q_2 heads with the E system. For 'HgBr' all the assigned band heads can be identified with the B system of CuBr; other unassigned bands of 'HgBr' coincide with bands of the A system of CuBr. The identity is quite convincing.

In Rao's experiments the copper probably came from the steel tube. I have observed³ CuCl bands in the spectrum of a flame burning in a steel tube. The identification of the emitting molecule of a new band system is not easy, but it is not always realized that impurities as frequently cause trouble in absorption as in emission. It seems desirable to point out incorrect assignments of this type to save later investigators wasting time, and possibly using incorrect data for theoretical work.

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¹ Rao, A. L. S., *Indian J. Phys.*, **16**, 393 (1942).

² Pearce, R. W. B., and Gaydon, A. G., "The Identification of Molecular Spectra" (Chapman and Hall, London, 1941).

³ Gaydon, A. G., *Proc. Roy. Soc., A*, **182**, 199 (1943).

Inverse Statistical Variates

HALDANE¹ has recently explained a method of using a haemocytometer in which counting is stopped when a fixed number of cells has been recorded. This sampling technique, with suitable modifications, can be applied to other populations and the theory reveals some interesting relationships.

In ordinary binomial sampling, if the variate (r) is the number of occurrences of a certain event when it is given a fixed number (N) of opportunities of occurring, in each of which the probability of occurrence is π , then the seminvariant-generating function of r is

$$L_N(t) \equiv \sum_{r=0}^N \ln \sum_{r=0}^N \pi^r (1-\pi)^{N-r} C_r^N \\ = N \ln (1-\pi + \pi e^t) = NL_1(t).$$

If, however, the number of occurrences is fixed (R), the probability that n opportunities will be required is equal to the probability that the event will occur $R-1$ times in the first $n-1$, compounded with the probability of an occurrence at the n th opportunity. Hence it is

$$\frac{(n-1)!}{(R-1)!(n-R)!} \pi^R (1-\pi)^{n-R},$$

(the coefficients being those of the expansion of a binomial of power $-R$), and the seminvariant-generating

function of n can be shown to be $-R \ln \left(1 - \frac{1-e^t}{\pi}\right)$.

This seminvariant-generating function is simply $RL_1^{-1}(t)$, where $L_1(L_1^{-1}(t)) \equiv t$ —a rather striking result. Moreover, the coefficients of variation of r and n are equal when $R = N\pi$. In this case, the value of R in the distribution of n is the mean value of r , while the value of N in the distribution of r is the mean value of n . In view of these relationships between the two distributions, I suggest that the sampling with a fixed number of occurrences should be termed *inverse binomial sampling*.

The Poisson limit is obtained on writing $\pi = k\mu$, $x = nk$, $X = Nk$, and then making k vanish while x , X and μ remain finite. The seminvariant-generating functions of r and x become $X\mu(e^t - 1)$ and $-R \ln(1 + t/\mu)$, which are of the form $Xf(t)$, $Rf^{-1}(t)$, where $f(f^{-1}(t)) \equiv t$; and the coefficients of variation are equal when $R = X\mu$. The first of these seminvariant-generating functions is that of the usual Poisson limit, while the second corresponds to a distribution of Pearson's Class III, in which the variate can take any non-negative value, and such a distribution could therefore be termed the *inverse* of the Poisson distribution. That inverse Poisson sampling with $R = 1$ gives a Class III distribution of this type has already been shown by Marsden and Barratt².

A similar relation appears in the theory of the effect of Brownian motion on the times taken by colloid particles to travel a fixed distance under electrophoresis or convection. The general theory, developed by using the properties of seminvariant-generating functions, will be published elsewhere, but a result relevant here is that if a number of particles are released in a plane at time $\tau = 0$ and the distribution of their distances from this plane is Gaussian with variance $\beta\tau$ after a time τ , β being a constant—so that, if their mean moves with constant velocity ω , the seminvariant-generating function of their displacements (x) from the original plane is $\eta(-\omega t + \frac{1}{2}\beta t^2)$, which is equal to $\eta F(t)$, say—

then the seminvariant-generating function of the times (y) taken by the individual particles to reach a parallel plane at a distance ξ is

$$\xi F^{-1}(t) = \xi(\omega - \sqrt{\omega^2 + 2\beta t})/\beta.$$

The corresponding distribution function has been given by Schrödinger³ and Smoluchowski⁴, who derived it by a different method. The coefficients of variation of x and y are equal when $\xi = \eta\omega$.

In general, if a variate x has the seminvariant-generating function $\alpha L(t)$, and another variate y the seminvariant-generating function $\beta L^{-1}(t)$, then their means are respectively αx_1 and β/x_1 and their variances αx_2 and $\beta x_2/x_1^3$, where x_1 and x_2 are the first and second seminvariants of the seminvariant-generating function $L(t)$. The coefficients of variation are equal if $\beta = \alpha x_1$, so that the mean value of x is β , while that of y is α . Thus, when the seminvariant-generating functions of x and y are so related, and the accuracy is measured by the coefficient of variation, y/β is as accurate an estimate of $1/x_1$ as x/α is of x_1 . Further, if the coefficient of variation is small, it is approximately the same for β/y , which is therefore as good an estimate of x_1 as x/α . I suggest that two variates related as x to y should be termed *inverse variates*, and either distribution may be said to be the *inverse* of the other.

I have been able to prove that the seminvariant-generating functions must be related in this way in the case of the Brownian motion problem, even when the latter is generalized by the removal of the assumption that the particles spread out on either side of their mean in a Gaussian manner. On the other hand, I have not been able to formulate a general sampling rule by which the inverse variate can be obtained from a given group of distributions, so that the definition of inverse variates remains a relation between their seminvariant-generating functions and between their means.

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¹ Haldane, *Nature*, **155**, 49 (1945).

² See Rutherford, Chadwick and Ellis, "Radiations from Radioactive Substances" (1930), §34c.

³ Schrödinger, *Phys. Z.*, **16**, 289 (1915).

⁴ Smoluchowski, *Phys. Z.*, **16**, 318 (1915).

MR. TWEEDIE's demonstration of the relation between the seminvariant-generating (or cumulant-generating) functions of two sets of related distributions is of great interest. However, the word "inverse" is already used in statistical theory, first in the phrase "inverse probability", and secondly in connexion with the problem of finding a distribution with a given characteristic function. If it is used in yet a third sense, some confusion may possibly arise, although "inversion" is already used in geometry and algebra with different meanings, and without inconvenience. It may be added that Mr. Tweedie's letter does not give an alternative solution of the problem raised by my own, since I am concerned with the distribution, not of n , but of $\frac{R-1}{n-1}$, which gives an unbiased estimate of the probability π .

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Bacteriological Studies of Pinosylvine, its Monomethyl and Dimethyl Ethers, and Toxicologic Studies of Pinosylvine

CONTRARY to what is true of sap-wood, pine heart-wood cannot be digested by the normal sulphite method. The cause of this has often been discussed. Investigations, especially by Hägglund and his co-workers, eventually disclosed that the cause must lie in the presence of certain substances in the heart-wood which can be extracted by suitable solvents.

In 1939, Erdtman isolated from such extracts two phenol substances which had not been described earlier, namely, pinosylvine (*trans*-3:5 dioxystilbene, $C_{14}H_{12}O_2$), and its monomethyl ether (*trans*-3-oxy-5-metoxystilbene, $C_{14}H_{11}O(OCH_3)$). The name is derived from *Pinus sylvestris*.

The physiological importance of the pinosylvine substances lies in the fact that they protect the dead heart-wood against wood-decaying fungi and insects. Pinosylvine is closely related to resorcin and its derivatives, 4-hexyl-resorcin being a well-known antiseptic. Pinosylvine may therefore be expected to have a bactericidal effect. Its toxicity was already observed by Erdtman in one of his experiments. He released some aquarium fishes, *Lebistus reticulatus*, in a weak solution of pinosylvine (0.002 per cent). The fishes died rapidly.

The toxicity of the pinosylvine substances in relation to wood-decaying fungi was investigated by Rennerfelt in 1943. Jorpes has tested the oestron effect of pinosylvine, this in view of its relationship to stilbene, but he could demonstrate no such effect.

As no bacteriological and no additional toxico-



Penicil.	Staphyl.
Subtil.	Tryph.

Pinosylvine and pinosylvine monomethyl ether are thus derivatives of stilbene and belong to a group of natural products which is as yet very small. Like stilbene, pinosylvine displays a bright violet fluorescence in ultra-violet light. Pinosylvine is very difficult to dissolve in water, its monomethyl ether still more so. On the other hand, these substances are easy to dissolve in alcohol, acetone and ether. The dimethyl ether is practically impossible to dissolve in water. The melting point of pinosylvine is $156^{\circ}C.$, that of its monomethyl ether $122-123^{\circ}C.$

logical studies have been made of the pinosylvine substances, the accompanying table gives a summary of my investigations carried out during 1943-44.

The table demonstrates the bactericidal effect of pinosylvine and its monomethyl ether as compared with that of phenol.

The accompanying figure shows the bactericidal effect of different concentrations of pinosylvine on bacteria cultivated on agar.

A summary of the results of all the bacteriological studies made of pinosylvine substances discloses that

		1 500	1 1,000	1 2,000	1 5,000	1 10,000	1 20,000	1 50,000	1 100,000	Aq.
Pinosylvine	<i>B. staphyloc. aureus</i>				—	—	±	+	+	
	<i>Penicillium</i>				—	—	±	+	+	
	<i>B. subtilis</i> (spores)			—*	+	+	+	+	+	
	<i>B. typhi murium</i>				+	+	+	+	+	
Monomethyl-ether	<i>B. staphyloc. aureus</i>				—	—	±	+	+	
	<i>Penicillium</i>				—	—	±	+	+	
	<i>B. subtilis</i> (spores)			+	+	+	+	+	+	
	<i>B. typhi murium</i>			+	+	+	+	+	+	
Phenol	<i>B. staphyloc. aureus</i>	—	—	±	+	+	+			
	<i>Penicillium</i>	—	±	±	+	+	+			
	<i>B. subtilis</i> (spores)	—	±	±	+	+	+			
	<i>B. typhi murium</i>	—	±	±	+	+	+			
Aq.	<i>B. staphyloc. aureus</i>									+
	<i>Penicillium</i>									+
	<i>B. subtilis</i> (spores)									+
	<i>B. typhi murium</i>									+

* In earlier experiments.

the inhibiting and bactericidal effect of pinosylvine is 7-30 times as strong as that of phenol in respect of *B. typha murum*, about thirty times as strong in respect of *B. staphylococcus aureus*, and about forty times as strong in respect of spores of *B. subtilis*. The inhibiting and bactericidal effect of pinosylvine monomethyl ether is about three times as strong as that of phenol in respect of *B. typha murum* and about ten times as strong in respect of *B. staphylococcus aureus*. Pinosylvine dimethyl ether, finally, has no demonstrable bactericidal effect, probably owing to it not possessing any group of free hydroxides. Pinosylvine and its monomethyl ether thus appear to possess the strongest bactericidal qualities hitherto demonstrated in any phenol compound found in Nature and isolated.

The toxicological investigations showed that the minimum lethal dose, calculated for a mouse of 15 gm., is 1-2 mgm pinosylvine in a 10 per cent alcohol solution, injected intraperitoneally. For the sake of comparison it may be mentioned that the corresponding value for phenol in water is 2.5 mgm injected subcutaneously. The toxic effect of pinosylvine is thus stronger than that of phenol and at the same time the poisoning symptoms are different, there being no convulsions.

Details of this work will be published in the *Nordisk Hygienisk Tidskrift*.

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Effects of Thiourea and Allylthiourea on the Germination of the Seed of *Striga lutea*

Striga lutea is a parasite belonging to the Scrophulariaceae which attacks the roots of a number of crop plants. As with some other closely allied species, the seeds will germinate normally only after exposure to a stimulant produced by a host root¹. Observations, however, on the effects on germination of a series of substances known to have biological activity in other connexions indicate that the host stimulant may be replaced, to a limited extent, by certain comparatively simple compounds. The experiments in which these observations were made involved incubating parasite seeds at 22° C for twenty-one days on moist filter paper, transferring them to another culture vessel provided with filter paper moistened with a solution of the experimental substance, incubating for a further period of some days at 22° C, and finally exposing the culture to 34° C for 24-48 hours. Thus the experimental process embodied three separate phases, each necessitated by a particular condition, the first by the fact that the parasite seed reacts vigorously to the host stimulant only after exposure to moisture for some days, the second by the effect of immediate exposure to the higher temperature with the substitute stimulant, which is that of inhibiting-germination, and the third by the fact that neither with the normal nor with the substitute

stimulant does extensive germination occur at the lower temperature, however prolonged is the period of incubation.

The effects of some forty-two compounds were examined, and of these only two—thiourea and allylthiourea—promoted any germination in the absence of the host stimulant. Thiourea was the less effective of the two, by treating the seed with a 1 per cent solution for three days in the second phase, and afterwards incubating for twenty-four hours in the third, a percentage germination of 36.9 was obtained. This, however, was an exceptional result, a variety of other treatments was tried, but they all gave considerably lower values.

The results in terms of percentage germination of an experiment with allylthiourea, in which the variables were solute concentration, the duration of the second phase, and the duration of the third, are given in the accompanying table.

Clearly the effect of the higher concentration is more rapid than that of the lower in that it yields the highest germination with two days, whereas the lower does so with five days of second-phase treatment. With both concentrations germination increases as the third phase is extended from twenty-four to forty-eight hours, and with both, prolongation of the second phase after a peak value is reached tends to depress germination. The effect of allylthiourea may be compared with that of the natural stimulant. Seeds exposed to the same treatment in the first phase as were those with which the values of the table were obtained gave after exposure to a host stimulant solution for six hours, followed by incubation with distilled water at 34° C for twenty-four hours, a percentage germination of 80.6. The treatment with the host factor for six hours corresponds to the second-phase treatment with the substitute, which extends over days. The concentration of the host stimulant used was unknown, but certain evidence suggests that it was certainly not greater than 1 part per 1,000,000. Thus, not only does the normal stimulant yield a higher percentage germination, but also it is effective at a very much lower concentration and acts very much more rapidly than allylthiourea. The differences are undoubtedly great, and they suggest corresponding differences in the chemical characteristics of the natural and substitute stimulants.

The present series of results are of some significance in relation to earlier reports on the breaking of dormancy in potato buds², maple seeds, acorns³ and lettuce seeds^{4,5,6} with thiourea and in lettuce seeds with allylthiourea⁴. In particular it may be noted that Thompson and Kossar, and later Rayleigh, found that thiourea has an inhibiting effect on the growth of the seedling, which according to the latter is avoided by washing the seeds after treatment for some hours with the stimulant. In the course of the present investigation a similar phenomenon has also been noticed. The effect of both substances is apparently twofold, at certain concentrations germination is induced, but although the seed coat is broken by a slight extension of the radicle, the latter, instead of

Duration of 2nd phase in days	1		2		3		4		5		6	
Duration of 3rd phase in hours	24	48	24	48	24	48	24	48	24	48	24	48
1.0 per cent solution	56.6	64.5	57.5	68.3	45.7	54.3	47.3	58.9	3.5	8.1	4.1	7.3
0.1 per cent solution	3.2	5.9	2.3	4.8	43.5	52.3	48.3	62.1	51.8	58.5	25.3	38.3

elongating, tends to form a spherical mass of tissue to which longitudinal growth is restored by washing the seeds in distilled water. In these cases growth is inhibited, but in certain others an inhibitory effect on germination itself may also be demonstrated. With prolonged exposure to the stimulant in the second phase, as indicated by the data presented above germination tends to decrease, but here again washing the seeds before exposure to a higher temperature in the third phase frequently restores a high percentage germination to the sample.

The similarity between the effects of the two substances on the development of dormant organs, and on the germination of the seed of *Striga lutea*, suggests a corresponding similarity in the internal conditions of the dormant organs and of the parasite seed before exposure to the host stimulant. On the other hand, it must be emphasized that the similarity is not close, since many substances which break dormancy have no effect on the parasite seed. For example, while Thompson and Kossar found that thiosemicarbazide, thioacetamide, ammonium thiocyanate, and potassium thiocyanate were also effective in inducing germination in dormant lettuce, the same substances have no effect with the seed of *Striga lutea*.

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¹ Brown, R., and Edwards, M., *Ann. Bot.*, **8**, 131 (1944).

² Denny, F., *Bot. Gaz.*, **81**, 297 (1926).

³ Deuber, C. G., *Science*, **73**, 320 (1931).

⁴ Thompson, R. C., and Kossar, W. F., *Plant Phys.*, **14**, 567 (1939).

⁵ Rayleigh, G. J., *Science*, **98**, 538 (1943).

⁶ Thompson, R. C., *Science*, **100**, 131 (1944).

Purification of Anterior Pituitary Corticotrophic Hormone

IN the course of attempts to purify the corticotrophic hormone of the pituitary anterior lobe in the past few years, it was noted that the corticotrophic hormone shows far greater solubility in alcohol than other pituitary anterior lobe principles, it was also found to be more thermostable. Fresh pituitaries were therefore refluxed with ten times their weight of absolute ethyl alcohol (final alcohol concentration about 95 per cent) at pH 5. Such extracts gave a far higher yield of corticotrophic activity than any other extraction method previously employed, but the most interesting fact found in connexion with the hot alcoholic extraction of the glands was that, on being filtered and cooled, the extract deposited a considerable amount of solid matter which quickly settled. The corticotrophic activity of both the supernatant fluid and of the deposit were estimated by the method of Reiss *et al.*¹ A considerable amount of corticotrophic activity was found in the fluid, but it was of particular interest that the acetone-dried deposit contained an unexpectedly high amount of corticotrophic hormone. Other anterior pituitary biological activity could not be found.

The supernatant liquid yielded—after concentration *in vacuo*—a further amount of solid material, which was also found to have a high degree of corticotrophic activity. We deduce, therefore, that the corticotrophic fraction is comparatively very soluble in warm alcohol, but sparingly soluble in cold alcohol.

The advantage of this method of purifying the corticotrophic principle would seem to be that an active corticotrophic hormone fraction is obtained which contains relatively little inert material or other anterior pituitary hormone.

The acetone-dried deposit can be completely dissolved in warm glacial acetic acid and such a solution forms on cooling, a partly crystalline precipitate. The further fractionation of the partly crystalline material and the investigation of its biological activity are being carried out.

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¹ *Endocrin.* **18**, 1 (1936).

Possible Synergistic Effect of Cod Liver Vitamin D on Synthetic Vitamin D₃

Stott and Harris suggest¹ that "when synthetic vitamin D₃ is blended with cod liver oil the assay, in international units, is higher than the calculated figure", and cite two typical results of tests using eighteen pairs of rats in each assay. They also cite the average figures for thirteen blends of cod liver oil, but there is some ambiguity as to whether the averages also apply to the calculated and ascertained potencies of the resulting mixtures.

While their conclusion is of course not impossible, prudence would suggest that if it is to be generally accepted, further and more precise data should be provided. Although it is clear from the context that the biological tests used depend on the cure of experimental rickets in the rat, the authors do not mention the precise method used.

Assuming either of the British Pharmacopoeia methods to have been used, the fiducial limits at $p = 0.99$, using ten pairs of rats, may be as wide as 49–215 per cent², but much will obviously depend on the precision attained in Stott and Harris's own laboratory. No indication of this is given. The point is of especial importance because no fewer than three biological assays enter into each comparison, namely, assays of the original oil, the vitamin D₃ concentrate and the final mixture.

With fiducial limits of the order of those cited in the British Pharmacopoeia—which may be even wider in the tests under discussion—it is obvious that many repetitions would be needed before an interesting possibility could be regarded as a statistically significant finding.

Further information should also be provided as to the genesis of the figures for the "synthetic vitamin D₃". This is presumably the commercial product which is, strictly speaking, not synthetic at all and which is normally assayed and sold—as required by law—in terms of B.S.I. units, not in terms of international units. Stott and Harris's use of the term 'international units' in this context presumably implies that they have re-assayed it on rats before use. If so, it would be of interest to see a comparison between the assay in B.S.I. units, on which the concentrate was purchased, and their assay in international units. If, on the other hand, no re-assay has been carried out, then the use of the term 'international units' is not justified.

In this latter contingency, the possibility of an under-estimate of the potency of the vitamin D₃ concentrate is by no means negligible. The B S I test—with or without minor modifications—has been carried out in these Laboratories for the past eight years, and I am indebted to my colleague, Dr M D Wright, for the information that the accuracy normally attained is indicated by fiducial limits at $p = 0.99$ of approximately 75–133 per cent. It is, therefore, possible—especially in view of the strict legal requirements as to potency declarations associated with these oils—that the vendor of the 'synthetic' vitamin D₃ may have deliberately sold it on the basis of a very conservative estimate of potency. It is suggested herefore that before Stott and Harris's conclusions are generally accepted, much more detailed information should be provided by them on this and the other points raised.

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Nature, 155, 267 (1945)

British Pharmacopoeia, 597 (1932), and Addendum (1936)

Pollen of Lime (*Tilia* spp.)

POLLEN production in small-leaved lime (*Tilia cordata* Mill.), as the following figures show¹, is comparable with that of durmast oak (*Quercus petraea* Liebl.)

Pollen output	<i>Tilia cordata</i>	<i>Quercus petraea</i>
Single flower	43,500	41,200
Ten-year-old branch system	89×10^4	111×10^4
Total for a pure stand 100 × 100 m	$5,600 \times 10^4$	$3,500 \times 10^4$
50-year total for a similar stand	$280,490 \times 10^4$	$34,410 \times 10^4$

Oak is a typically anemophilous tree, and its pollen production in certain years at least is well known to be correspondingly high—the figures therefore need no comment. Two other groups of facts bear out the importance of pollen production in *Tilia*.

(1) Lime pollen occurs in quantity in English and Welsh peat deposits covering a long period of post-glacial time, and its presence in substantial proportion is held by Godwin² to characterize the warmest phase of that period. Pollen analysis of a peat from the East Moors, Cardiff³, showed that at one horizon 3 per cent of the total tree pollen was lime.

(2) Lime pollen is present at certain times in considerable quantity in the atmosphere near lime trees and can be caught on adhesive surfaces exposed in the vicinity. Thus the following quantities of *Tilia* and other pollen (mainly grass) respectively were caught on 5 sq cm of a slide exposed horizontally on the roof of the National Museum of Wales, Cardiff (10 ft above ground) on the dates stated⁴: 1942, June 29–July 1 (48 hours), *Tilia* 174, other pollen 34; July 1–2 (24 hours), 274 and 222; July 2–3, 9 and 306; 1943, June 30–July 1, 34 and 97. Similar counts were obtained from slides exposed for 24 h, by the courtesy of Prof F T Brooks, on the roof of the Botany School, Cambridge, in 1943, namely, June 26–28, *Tilia* 173, other pollen 193; June 28–29, 36 and 60; June 29–30, 66 and 94.

So far from producing little pollen (as claimed by Yate Allen in the statement quoted by Mr

Cartwright Farmiloe⁵) lime seems to be an outstanding example of a plant which, notwithstanding the fact that its flowers produce nectar and are regularly visited by insects in consequence, yet produces and sheds also an abundance of pollen.

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¹ Erdtman, G., "An Introduction to Pollen Analysis" (Waltham, Mass., 1943)

² *New Phyt.*, 39 (1940)

³ Hyde, H A. *Trans. Cardiff Nat. Soc.*, 69 (1936)

⁴ Hyde, H A., and Williams, D A. (unpublished)

⁵ *Nature*, 155, 80 (1945)

Naga, Naja, Naia or Naya?

In paragraph 19 of the review in *Nature* of October 21, 1944, of "The Fauna of British India", Colonel Wall states: "The generic name of the cobra should be altered to *Naga*. It was clearly the intention of Linnaeus to attach to it the name by which it is universally known to the natives of India—'nag' (pronounced narg). It is probable that this information was conveyed by letter and that he mistook the 'g' for 'j'. *Naya*, and still less the *Naia* of some authors, have no meaning."

The two common Singhalese names for cobra are 'nāgayā' and 'naiā', or more correctly, 'nayā', and if, as Colonel Wall states, it is probable that Linnaeus's information was conveyed to him by letter and that he mistook a 'g' for a 'j', is it not equally probable either his correspondent considered 'j' and 'i' interchangeable, as has been customary, or that he actually wrote 'y', which Linnaeus mistook for 'j'?

'Naja' has certainly no meaning to a Singhalese, but 'naiā' or 'nayā' will make him jump.

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P J. Kipp

THE description by the author of a recent communication¹ of the apparatus for the continuous generation of gases at the ordinary laboratory temperature as a 'kip' is almost an insult to the work and memory of P J Kipp². This eminent Dutch chemist was born more than a hundred years ago at Delft, where he founded the well-known firm of P J Kipp and Sons to which many chemists and physicists have been, and hope to be again, indebted for beautifully made scientific apparatus. A representation of Kipp's apparatus is incorporated in the seal of the Dutch Chemical Society.

We have become accustomed to the abbreviation of the name of the familiar burner as a 'Bunsen' and we may speak of Kipp's apparatus as a 'Kipp', but I, for one, hope it will never be described again as a 'kip'.

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¹ Robertson, *Nature*, 155, 395 (1945)

² *Chem. and Ind.*, 5, 509 (1930).

SCIENTIFIC AND INDUSTRIAL RESEARCH IN AUSTRALIA

THE seventeenth annual report of the Council for Scientific and Industrial Research, Commonwealth of Australia*, covers the year ended June 30, 1943, in which the total expenditure of the Council was £541,283, of which £106,126 was contributed from sources other than the Commonwealth Treasury. A large part of the Council's activities is now devoted to the solution of problems arising out of the War and to assistance and advice to Government Departments and other institutions and organizations concerned with the war effort, particularly the work of the National Standards Laboratory and the Departments of Aeronautics, Forest Products and Industrial Chemistry. Reference to these activities in the report is either confined to brief general statements or entirely omitted.

The work of the Division of Plant Industry followed the lines of last year. The Division continued to prosecute investigations leading to the production of essential drug plants, including those on poppy, pyrethrum, cinchona, *Duboisia* and *Ephedra*. In this work the Medical Equipment Control Committee of the National Health and Medical Research Council, the Department of Pharmacy, University of Sydney, the Physiology Department of the University of Melbourne, and the Forestry Department of Queensland are co-operating. Special attention is being paid to studies of plants likely to serve as a source of rubber, particularly to guayule and *Taraxacum koksaghyz*. Work is being continued on microbiological retting of flax, with some interesting results which may have an important bearing on the process. In spite of great difficulties owing to the shortage of seed and increased requirements, the Commonwealth Vegetable Seeds Committee, set up in January 1942, operated under the chairmanship of the chief of the Division until January 1943, and the foundations have been laid for the development of a permanent industry.

Entomological investigations carried out for the medical branches of the Fighting Services have been very fruitful. Valuable practical results have come from the studies of the insect pests of stored wheat and wool. The work on insect pests of stored wheat has covered control measures in bulk depots, the fumigation of bag-sacks and the sterilization of stack sites. In testing some Australian nitrated cresols, it was found that mineral oil emulsion containing 5 per cent commercial grade dinitro-o-cresol was comparable in toxicity with the proprietary emulsion. Fumigation experiments have been carried on with the view of selecting material for use as sprays or solid fumigants against infested stacks of stored wool, and a nozzle has been designed which enables satisfactory distribution of liquid sprays to be obtained within a wool stack when used in conjunction with a jetting plant, and a technique for spraying stacks from above has been devised. The potato moth caused severe crop losses on the mainland during 1942-43, and experiments were carried out with a number of materials used as sprays for the control of potato larvæ in the haulms in the field, basic copper arsenate giving the most promising results.

In the field of animal health and nutrition more attention has been given to the immediate needs of the animal industry and to the application of exist-

ing knowledge to prevent waste. Investigations at the Animal Health Research Laboratory, Melbourne, have covered pleuropneumonia of cattle, mastitis in dairy cattle, contagious abortion, a study of the mechanics of hand-feeding sheep, and the toxicity of wheat for stock. The McMaster Animal Health Laboratory has continued its studies of phenothiazin in the control of nodular worm and of the large stomach worm in sheep, as well as its work on dipping and dipping. The study of the physical properties of wool has been interrupted, but in the field of wool biology further advance has been made towards establishing a method of analysis by which the many sources of biological variation within and between fleeces can be studied under well-controlled and uniform conditions. The Animal Nutrition Laboratory, Adelaide, has brought its investigations on energy metabolism of sheep to a stage ready for preparation for publication as a scientific monograph.

The work of the Division of Soils in the first half year was largely concentrated on defence projects and field surveys of laboratory research have been restricted through lack of staff. The main change has been the initiation of a programme of investigations in soil mechanics, principally concerning soil cement, which it is proposed to continue as a major project. Investigations on the stabilization of soils with pure calcium chloride showed that dressings of 1 to 6 lb pure calcium chloride per square yard were insufficient to stabilize soils in inland southern Australia under concentrated traffic. The Commonwealth Research Station at Merbein, Victoria, was established primarily to investigate problems associated with the production and processing of dried fruit, including irrigation of the land and maintenance of soil fertility. Some of the investigations have been suspended during the last two years and replaced by investigations dealing with special war-time requirements, but the experience of the Station in primary production under irrigation conditions and in drying foodstuffs is being fully utilized by the Commonwealth Department dealing with the processing and storing of dried fruits and vegetables and in the production of special crops not previously grown in commercial quantities in Australia. Fruit drying investigations have now been extended to practically all dried fruits required by the supply authorities. The Station has assisted in the development of about 500 acres of land brought under irrigation since the outbreak of war. The plants grown include vegetables at military establishments, grass covers for aerodromes and drug plants. The Irrigation Research Station at Griffith, New South Wales, established in 1924, has been considerably expanded owing to pressing problems in maintaining the production of fruit and increasing that of vegetables. The long-term citrus cover-crop plants at the Station have demonstrated the value of lucerne in controlling excess soil moisture, salt and structural deterioration. Vegetable investigations have been concerned mainly with irrigation, the germination of seeds, particularly of carrots, and weed control. The Station has also assisted in defining soil and slope suitability standards as a guide to the use of land for citrus.

The main activity of the Division of Forest Products has continued to be advisory work for the various branches of the Services and industry. Steady progress has been made in investigations basic to aircraft production, such as the development of improved wood and the use of timbers for aircraft plywood other than those already approved. Problems

* Seventeenth Annual Report of the Council for Scientific and Industrial Research, for the Year ended 30th June 1943. Pp. 76 (Canberra: Commonwealth Government Printer, 1944.) 3s. 4d.

rising out of the treatment of timber to fit it for use in tropical areas are under investigation. New laboratories have been erected for paper-testing work and for flax, but much experimental work is awaiting development in connexion with the newer types of synthetic resin glues and methods of plywood manufacture and use.

The work of the Division of Food Preservation and Transport has also been almost entirely devoted to problems of direct importance in the war effort. The canning and dehydration of foodstuffs continue to be the most important fields of investigation for the Division. The Meat Investigation Laboratory at Brisbane has been concerned chiefly with dehydrated beef, and the investigations have led to a closer definition of ideal processing conditions and may reduce processing costs. Particular attention has been given to the improvement of flavour. In work in storage it was observed that the dried meat is very subject to infestation by a beetle, *Dermestes ulpinus*. Other investigations have covered a survey of the vitamin C content of tomato varieties grown in the Bathurst district and of the vitamin C content during the processing of canned tomatoes, tomato juice and tomato puree. Meat-canning investigations have also assisted with production programmes, and container investigations have led to the development of technique and equipment for the rapid testing of cans. An attempt has been made to obtain fundamental data in this field, including studies of the effect of variations in template thickness on closing-machine adjustments. Experiments to determine the storage life of different samples of dried egg under various conditions have continued, but the storage experiments on dried mutton have been completed. The Microbiological Section has been concerned almost entirely with canned foods and investigations on eggs. Fruit-storage investigations have included skin coatings on apples, the best results were obtained by hand dipping the apples in an alcoholic solution of 8 per cent castor oil and 2 per cent of de-waxed shellac. The treated fruit was less wilted, firmer, crisper and more juicy and the flavour and acid were retained longer. Wax emulsions are more effective than oil emulsions in retarding loss of moisture, but require higher concentrations and more alkaline soaps. The Fruit Products Section has been largely responsible for organizing the large-scale production in several States of canned and bottled citrus juices for antiscorbutic purposes in Service rations. The production of canned apple juice fortified with synthetic vitamins was also commenced in New South Wales and Tasmania, and research has been carried out on substitute containers, the smoke curing of fish, and electrical moisture meters.

The Fisheries Investigations Division carried out a comprehensive survey of the fishing industry for the man-power authorities, and technical work connected with the manufacture of agar was done in conjunction with various firms interested. An extensive survey of seaweeds suitable for this purpose is at present being carried out by the Division. A pilot plant for the manufacture of sodium alginate, potash and iodine is working in Sydney. Livers of twenty species of shark and ray have been examined for oil and vitamin content in an effort to find livers rich in vitamin A and possibly vitamin D to augment supplies being used in Victoria. The withdrawal of the research vessel *Warreen* from service during the year broke the continuity of the tuna observations on the south-east coast.

In the Industrial Chemistry Division, the Biochemistry Section continued research designed to assist the fellmongering industry, while the Minerals Section assisted in the commercial utilization of Australian minerals by devising and adopting chemical treatments necessary for the manufacture of a wide range of chemical compounds from crude ores and minerals, chromite, monazite, fluorite, bauxite, graphite, pyrolusite, rutile, beryl and rock phosphate received the main attention during the year. The whole of the research work in physical metallurgy of the Divisions of Industrial Chemistry and Aeronautics has now been consolidated in one Section of Physical Metallurgy, included for administrative purposes within the Division of Industrial Chemistry.

The Organic Chemistry Section has constructed and operated a pilot plant for the manufacture of ethylene. A pilot plant is also being constructed for the manufacture of ethylenedichlorohydrin by a continuous process. Preliminary preparations of a synthetic rubber of the 'Thioplast' type have been made, and phenol and cresol-formaldehyde resins have been investigated to discover resins suitable for the production of compressed woods and as hot glues for plywoods, compressed woods, and wood-metal joints. A method of analysis developed in the laboratory gives valuable information when applied to resins of outside origin. Resins of the aniline/formaldehyde type are also being developed as moulding powders for some electrical work and as adhesives for compressed woods. Surplus fatty acids have been examined as possible sources of substitute waxes, and a method of estimating the mannitol in the exudation from trees, *Myoporum platycarpum*, has been completed, and the isolation of the material on a pilot-plant scale is under investigation. The section concerned with lubricants and bearings have been engaged primarily on confidential war work.

The Information Section has made a distinct contribution to the war effort in the preparation of summaries and bibliographies connected with aspects of technical productions, and in the compilation of information on the substitution of Australian raw materials for materials formerly imported. Officers of the Section have continued to act as an abstracting panel for the preparation of *Australian Chemical Abstracts*, published by the Australian Chemical Institute, which are confined entirely to reports and articles published in Australia, and to Australian patents.

PENICILLIN TREATMENT OF VENEREAL DISEASE AND SPIROCHÆTAL INFECTIONS

THE remarkably successful treatment of gonorrhoea with penicillin was recorded in an earlier note on penicillin treatment (*Nature*, 677, Nov 25, 1944). In that note also the opinion of United States Army medical men that the immediate effects of penicillin in the treatment of syphilis are better than those of arsenical preparations was recorded. Leading articles in the *Lancet* (853, Dec 30, 1944) and the *British Medical Journal* (821, Dec 23, 1944) discuss the whole question of penicillin treatment of human syphilis, with references to the relevant literature.

In the United States the first experiments on this problem were done on rabbits infected with syphilis, and J. F. Mahoney, R. C. Arnold and A. Harris

(*Ven Dis Inform.*, 24, 355, 1943) were apparently the first to record penicillin treatment of human syphilis. In Britain, E M Lourie and H O J Collier (*Ann Trop Med and Parasitol*, 37, 200, 1943) showed that penicillin will cure infections of mice with *Treponema recurrentis* and *Spirillum minus*. In co-operation with A O F Ross and R B Wilson (*Lancet*, 845, Dec 30, 1944) they report on the treatment of five cases of human syphilis with penicillin. All these cases had well-marked secondary lesions, and the immediate response "could not have been bettered by any known form of treatment". The spirochaetes and lesions disappeared at least as rapidly as they do under treatment with arsenicals and bismuth. But all these cases were in the secondary stage of the disease, and later observations upon them showed that only one of the five cases was apparently cured. It was therefore doubtful whether penicillin was as beneficial as arsenicals and bismuth would have been. These authors concluded that penicillin will not become suitable for routine civilian practice until frequently repeated day- and night-injections can be avoided.

The problem of dosage in the treatment of syphilis is discussed by both the *British Medical Journal* and the *Lancet* (*loc cit*). In the United States, where so much more penicillin is available, extensive trials of it for the treatment of syphilis have been going on at thirty-one centres, and the *Lancet* discusses the reports on these and the supply of penicillin, stating that, by April 1944, the tentative production programme of the United States and Canada was, according to R. D Coghill (*Chem Engineer. News*, 22, 588, 1944), of the order of 200,000 mega units (1 mega unit is 1 million Oxford units). There will be general agreement that we are justified in expending a large proportion of even the limited British supplies of penicillin on the study of its effects on syphilis. Arsenical treatment is more toxic and is not infallible, it involves supervision of the patient for a year or longer, and J Marshall (*Nature*, 153, 187, 1944) has pointed out that less than half the patients get enough of such treatment to ensure a cure-rate of 80 per cent, because they default. One danger of future penicillin treatment is emphasized by both the *Lancet* and the *British Medical Journal* (*loc cit*). A patient may have both gonorrhoea and syphilis at the same time. The gonococcus is more susceptible to penicillin than the spirochaete of syphilis. Treatment with doses of penicillin which are sufficient to cure the gonorrhoea may therefore suppress the early signs of the syphilis, without being sufficient to cure this disease, especially if the syphilis is at an early stage when the only sign of it may be a hidden chancre. The diagnosis of syphilis may therefore be only made later when the secondary signs appear. F L Lydon and W R S Cowe (*Brit. Med J*, 110, Jan 27, 1945) also discuss this subject, adding the point that battle casualties treated with penicillin for gonorrhoea, for which it is, they agree, the drug of choice, may be incubating syphilis as well, which would thus escape detection. They think that routine blood-tests should be enforced by law upon the whole population. Similar cases of coincident infections with these two venereal diseases are discussed by F A Ellis (*J Amer Med Assoc*, 126, 80, 1944) and by C R Wise and D M Spillsbury (*Brit J Surg*, 32, 214, 1944).

Penicillin seems to be very effective also against other spirochaetes and their relatives. Brigadier G M Findlay, Major K R Hill and A Macpherson (*Nature*,

795, Dec 23, 1944) report some success in the treatment with penicillin of yaws, due to *Spirochaeta penae* and of tropical ulcers infected with spirochaete fusiform bacilli and other organisms. Ulcers have caused, during 1944, the loss of 30,000 men-days among West African troops. A B MacGregor and D Long (*Brit Med J*, 686, Nov 25, 1944) report the rapid disappearance of *Treponema vincenti*, the cause of Vincent's gingivitis, under treatment with penicillin incorporated in pastilles. J M Alston and J Broom (*Brit Med J*, 718, Dec 2, 1944) report their experiments on its action on nine strains of *Leptospira icterohaemorrhagiae*, the cause of Weil's disease (six strains were human, two were from rats and one from a dog) and on one strain of *L. canicola*, the cause of another form of leptospiral infection in man and dogs. Penicillin killed all these strains in cultures and also inhibited their multiplication. It also cured infections of guinea pigs with leptospira virulent to them, provided that it was given early enough (eighteen hours after infection). It did not prevent the development in the guinea pigs of serum antibodies or resistance to re-infection. It was not toxic to the guinea pigs as others have reported to be. In the same issue of the *British Medical Journal* (p 720), V Lloyd Hart reports upon the treatment of one Italian male suffering from Weil's disease. The results suggest that even the very small dose given at relatively long intervals, had some curative effect, but Hart also emphasizes the need for early administration. It is, however, difficult to diagnose Weil's disease in its early stages. The same necessity for early administration is emphasized by B E Bulmer (*Brit Med J*, 113, Jan 27, 1945) in his summary of the treatment by various medical officers of sixteen cases of the same disease in Normandy. It is thought that Weil's disease is spread by infected rats, which pass the spirochaetes in their urine. The spirochaetes can live for a time in stagnant water wells and sewers, so that men infect themselves by drinking and bathing. Up to December 1944, cases had been notified between mid-July and the end of September, and only from Normandy. It is, Bulmer thinks, surprising that cases have not occurred in the Low Countries, where there is "plenty of water". There was great difficulty in assessing the results of the penicillin treatment. The liver and kidney are rapidly damaged by the spirochaete, so that penicillin should ideally be given before the diagnosis can be made. Inadequate doses of penicillin appeared, however, to shorten the duration of the fever and to cause dramatic improvement, especially when high doses were given. It did not appear to influence the damage done to the liver and kidney. In the same issue of the *British Medical Journal* (p 119), A I Carragher reports on the treatment of one other case, a soldier invalided from France. After only six injections of penicillin the *Leptospira* disappeared from the blood and there was rapid clinical improvement.

Among other organisms of the spirochaete type are *Streptobacillus moniliformis* and *Spirillum minus*, the causative organisms of the two rat-bite fevers. The reasons for the conclusions that two organisms are concerned in the etiology of this disease have been discussed (*Lancet*, 540, Oct. 21, 1944), together with the effect of penicillin on them. F R Heilman and W E Herrell (*Proc Staff Meeting, Mayo Clinic*, 15, 257, 1944) and H Eagle and H J Magnuson (*Pub Health Rep Wash*, 59, 583, 1944) have confirmed the results obtained by Lourie and Collier mentioned

above Heilman and Herrell found that penicillin cured mouse infections with *Sp. minus* and *Strept. moniliformis*, so that both forms of rat-bite fever may prove susceptible to it. The former responds dramatically to organic arsenicals, but the latter resists ursemic, sulphonamides and gold treatment. F. F. Kane (*Lancet*, 548, Oct 21, 1944) reports on the infection of an Ulster boy with *Strept. moniliformis* as the result of a rat-bite, which was successfully treated with penicillin after gold treatment had failed. Eagle and Magnuson obtained cures with penicillin of infections of rats and mice with *Spirochaeta recurrentis* (= *Treponema novyi*), so that it is possible that penicillin may prove better than arsenic for the treatment of relapsing fever of man, which is caused by this organism. G. LAPAGE

FORESTRY AND THE PUBLIC WELFARE

AT the autumn general meeting of the American Philosophical Society held in the hall of the Society on November 17-18, 1944, the first day was devoted to a symposium on "Forestry and the Public Welfare", brief papers being read (among others) on forests in relation to soils and water (Raphael Zon), world-wide needs of woods (W. C. Lowdermilk), public control of cutting practices on private timberland (Joseph F. Kaylor), and forest conservation—public and private co-operation (Wilson Compton).

Zon's research work in connexion with forests, soils and water is well known. He gave a brief summary of important points. The longer precipitation remains in circulation over the land before, as run-off, it reaches streams and ocean, the greater its use to the land. The greatest effect of forests upon water is therefore that they tend to prolong this water-cycle in and in the soil. In deep soils a large reservoir of ground water is retained which only gradually but regularly feeds the streams, thus preventing exceptional high rises resulting in floods, or low levels which diminish agricultural supplies. The protective cover of the forest reduces wind damage, decreases evaporation from the soil, reduces the temperature of the air and soil within the forest during the summer and raises it in winter. Growing trees transpire and thus increase the humidity of the air over forests, while their roots stabilize the soil.

Lowdermilk, in discussing the world-wide needs of woods, pointed out that man has grown up with wood, that he has always utilized the substance in the past, and human progress, in spite of the many substitutes, demands ever larger amounts. Wood, he said, is "a natural wonder of chemistry and physical structure", but cellular structure and chemical content of cell cavities give rise to a wide variety and many properties that serve hundreds of uses, even to paper and clothing fabrics. Modern technology has by special treatment of impregnation and compression produced new materials from wood that compete with metals. Chemical industries are opening up amazing possibilities in deriving from wood as raw material new chemicals based on fermentation of carbohydrates, even to the making of alcohol for rubber manufacture. On the subjects of demand, Lowdermilk said that the production of wood, reported as some 1.2 billion tons, is second only to that of fossil carbonized wood as coal, namely, 1.3 billion tons, and is practically tenfold that of steel.

America has long halted at the cross-roads of State interference in any way with the operations of the lumberman; enormous areas have been felled without a thought to the future, while fire has destroyed additional large areas of virgin forest. In his paper on public control of private felling, Kaylor said that within the last few years sentiment in many parts of the United States has veered strongly towards some form of public control of private felling, the cumulative results of the unrestricted cuttings of the past now being more fully realized. A difference of opinion exists as to whether such control should be exercised by the individual States or by the Federal Government. Kaylor spoke for Maryland, stating that in 1943 the legislature of the State passed the Forest Conservancy Districts Act authorizing a Commission of State Forests and Parks to draw up rules of forest practice for all the privately owned forests of the State—certainly a move in the right direction.

Dealing with public and private co-operation in forest conservation, Wilson Compton discussed briefly the exploitation of the forests in the past and the results of surveys of the forests still existing in parts of the United States and the work of conservation now being carried out. The surveys showed that there are nearly a thousand tree farms comprising 10 million acres in the western and southern States, and the number is being constantly added to. In 1941 the National Lumber Manufacturers' Association co-operated with the forestry departments of thirty-seven States in a survey of 153 million acres of privately owned timber lands—the so-called industrial forest lands, of these, 25 million acres were under working plans, 45 million under less intensive management, another 73 million acres with reasonably satisfactory reproduction, but not adequately protected from fire. In other words, about 94 per cent of the area surveyed was considered to be in a "reasonably productive condition". When the total disregard shown for the immense forest estate exploited by the United States for so long, as if it were inexhaustible, is remembered, it is a good augury that the lumber companies, and to some extent the private forest owner, should have realized where unchecked exploitation was leading the country and its important industries.

FORTHCOMING EVENTS

(Meeting marked with an asterisk * is open to the public)

Monday, April 16

ROYAL SOCIETY OF ARTS (at John Adam Street, Adelphi, London, W C 2), at 1.45 p.m.—Sir Frank Smith, G C B, G B E, F R S "Chemicals from Petroleum" (Cantor Lectures, 1)

FARMERS' CLUB (at the Royal Empire Society, Craven Street, Strand, W C 2), at 2.30 p.m.—Mr H. W. Grimmer "Present and Future Aspects of Electricity in Agriculture" *

ASSOCIATION OF AUSTRIAN ENGINEERS, CHEMISTS AND SCIENTIFIC WORKERS IN GREAT BRITAIN (CHEMICAL GROUP) (at the Austrian Centre, 69 Eton Avenue, Hampstead, London, N W 3), at 7.30 p.m.—Mr B. Chilton "Present-day Problems of Industrial Photography" *

ROYAL GEOGRAPHICAL SOCIETY (at Kensington Gore, South Kensington, London, S W 7), at 8 p.m.—Dr H. L. Richardson "Szechwan during the War" *

Tuesday, April 17

INSTITUTION OF NAVAL ARCHITECTS (at the Institution of Mechanical Engineers, Storey's Gate, St James's Park, London, S W 1), at 10.30 a.m.—Admiral of the Fleet the Rt Hon Lord Chatfield, G C B, O M "Presidential Address. Sir Amos L. Ayre, K B E "Merchant Shipbuilding during the War". At 4.30 p.m.—Mr E. H. Watts "Crews' Accommodation in Tramp Ships", Mr A. J. Sims "The Habitability of Naval Ships under Wartime Conditions" *

ROYAL SOCIETY OF ARTS (DOMINIONS AND COLONIES SECTION) (at John Adam Street, Adelphi, London, W C 2), at 1.45 p.m.—Dr Charles Cammell "The New Programme of Field Investigation in the Canadian North-West" *

BRITISH SOCIETY FOR INTERNATIONAL BIBLIOGRAPHY (at the Institution of Electrical Engineers, Savoy Place, Victoria Embankment, London, W C 2), at 2 30 p m—Annual General Meeting, Presidential Address

INSTITUTION OF ELECTRICAL ENGINEERS (RADIO SECTION) (at Savoy Place, Victoria Embankment, London, W C 2), at 5 30 p m—Discussion on "Design of Broadcast and Television Receivers for the Post-War Market" (to be opened by Mr L H Bedford)

Wednesday, April 18

ROYAL SOCIETY OF ARTS (at John Adam Street, Adelphi, London, W C 2), at 1 45 p m—Sir Edward Appleton, K C B, F R S "The Work of the Department of Scientific and Industrial Research"

ROYAL SOCIETY OF MEDICINE (at 1 Wimpole Street, London, W 1), at 2 15 p m—Discussion on "The Control of Rickettsial Infections" (to be opened by Lieut-Colonel C H Stuart-Harris, Dr J S Carmichael and Dr Raymond Lewthwaite)

INSTITUTION OF NAVAL ARCHITECTS (at the Institution of Mechanical Engineers, Storey's Gate, St James's Park, London, S W 1), at 2 30 p m—Mr W Thomson "Some Cases of Failure of Deck Plating due to Stranding", Mr W I Hay "Some Notes on Ships' Structural Members", Mr J M Murray "Notes on Deflected Plating in Compression and Tension" At 4 30 p m—Prof T H Havelock, F R S "Notes on the Theory of Heaving and Pitching", Mr J F Allan "The Stabilisation of Ships by Activated Fins"

GEOLOGICAL SOCIETY OF LONDON (at Burlington House, Piccadilly, London, W 1), at 3 p m—Scientific Papers

INSTITUTE OF PETROLEUM (joint meeting, with the BRITISH RHEOLOGISTS' CLUB) (in the Lecture Hall of the Royal Society of Tropical Medicine and Hygiene, 26 Portland Place, London, W 1), at 3 30 p m—Dr A Cameron "Determination of the Pressure Viscosity Coefficient", The Viscosity Panel "Precision and Accuracy of Viscosity using B S I Tubes", Mr E R Pethrick "The Testing of Greases for Ball Bearings", Mr E W Hardman and Dr A H Nissan "A Rational Basis for the Viscosity Index System", Dr A Lahiri and Dr E W J Mardles "The Problem of Engine Deposits", Dr A S C Lawrence "Lubricating Greases"

ROYAL METEOROLOGICAL SOCIETY (in the small Physics Lecture Theatre, Royal College of Science, Imperial Institute Road, South Kensington, London, S W 7), at 4 30 p m—Mr G E R Deacon, F R S "Water Circulation and Surface Boundaries in the Oceans" (Symons Memorial Lecture)

ILLUMINATING ENGINEERING SOCIETY (at the E L M A Lighting Service Bureau, 2 Savoy Hill, London, W C 2), at 5 30 p m—Mr R Maxted and Mr J N Hull "Circuits for Discharge Lamps"

Thursday, April 19

CHEMICAL SOCIETY (at Burlington House, Piccadilly, London, W 1), at 11 30 a m—Annual General Meeting At 2 30 p m—Prof W N Haworth, F R S "Starch" (Presidential Address)

ELECTRICAL ASSOCIATION FOR WOMEN (at the Institution of Electrical Engineers, Savoy Place, Victoria Embankment, London, W C 2), at 2 p m—Twentieth Annual Conference

INSTITUTION OF NAVAL ARCHITECTS (at the Institution of Mechanical Engineers, Storey's Gate, St James's Park, London, S W 1), at 2 30 p m—Mr T C Tobin "The Dynamics of Launching", Mr E O Stephens "Thames (Dumb) Barges" At 4 30 p m—Dr G Hughes "On Singing Propellers", Mr V D Naylor "The Concept of Pitch"

BRITISH INSTITUTE OF RADIOLOGY (in the Reid-Knox Hall, 32 Welbeck Street, London, W 1), at 8 p m—Prof E A Owen "The Silvanus Thompson Memorial Lecture"

Friday, April 20

BRITISH INSTITUTE OF RADIOLOGY (in the Reid-Knox Hall, 32 Welbeck Street, London, W 1), at 4 45 p m—Dr J F Brailsford "Reflections in the Teaching of Radiology" (Mackenzie Davidson Memorial Lecture)

INSTITUTION OF ELECTRICAL ENGINEERS (MEASUREMENTS SECTION) (at Savoy Place, Victoria Embankment, London, W C 2), at 5 30 p m—Dr L Hartshorn and Mr W Wilson "An Electrical Moisture Meter"

Saturday, April 21

SOCIETY OF INSTRUMENT TECHNOLOGY (at the London School of Tropical Medicine, Keppel Street, Gower Street, London, W C 1), at 11 a m

ASSOCIATION FOR SCIENTIFIC PHOTOGRAPHY (at Causton Hall, Westminster, London, S W 1), at 2 30 p m—Mr E Mackie "A Consideration of the Requirements for Micrography and Cinemicrography Apparatus"

APPOINTMENTS VACANT

APPLICATIONS are invited for the following appointments on or before the dates mentioned.

LECTURER (full-time) IN ELECTRICAL ENGINEERING—The Principal, Royal Technical College, Peel Park, Salford 5, Lancs (April 21)

CHAIR OF PHILOSOPHY in the University of Otago, Dunedin—The High Commissioner for New Zealand, 415 Strand, London, W C 2 (April 28)

LECTURER (woman) IN ZOOLOGY—The Principal, Royal Holloway College, Englefield Green, Surrey (April 28)

ASSISTANT LECTURER (temporary) IN MATHEMATICS—The Registrar, University College, Exeter (April 28)

CHIEF ANALYTICAL CHEMIST in the Research Department of a well-known firm in the London area—The Ministry of Labour and National Service, Appointments Department, Central (T and S) Register, Room 5/17, Sardinia Street, Kingsway, London, W C 2 (quoting Reference No F 3673 XA) (April 28)

SCIENTIFIC OFFICER (CHEMIST, male) at the West Midlands Forensic Science Laboratory at Birmingham—The Ministry of Labour and National Service, Central (T and S) Register, Room 5/17, Sardinia Street, Kingsway, London, W C 2 (quoting Reference No F 3859 A) (April 30)

METALLURGIST in the Research Department of a large firm in Yorkshire—The Ministry of Labour and National Service, Appointments Department, Central (T and S) Register, Room 5/17, Sardinia Street, Kingsway, London, W C 2 (quoting Reference No F 2721 XA) (April 30)

HEADMASTER OF PERSE SCHOOL—The Clerk to the Governors Montagu House, Sussex Street, Cambridge (endorsed 'Headmaster') (April 30)

SUPERINTENDENT in a Government establishment (candidates should be well qualified in CHEMISTRY or CHEMICAL ENGINEERING, and should have experience in the Manufacture of Explosives and also in the Development of Chemical Processes)—The Ministry of Labour and National Service, Central (T and S) Register, Room 5/17, Sardinia Street, Kingsway, London, W C 2 (quoting Reference No F 3886 A) (April 30)

LECTURER IN MATHEMATICS in the Brighton Technical College—The Education Officer, 54 Old Steane, Brighton (April 30)

LECTURER IN ELECTRICAL ENGINEERING, with qualifications in TELECOMMUNICATIONS and LIGHT-CURRENT ENGINEERING, particularly ELECTRONICS—The Clerk to the Governing Body, Battersea Polytechnic, Battersea, London, S W 11 (May 2)

ASSISTANT LECTURER IN ZOOLOGY, with special qualifications in ENTOMOLOGY or HELMINTHOLOGY—The Secretary, West of Scotland Agricultural College, Blythswood Square, Glasgow (May 5)

GENERAL SECRETARY—The Honorary Secretaries, Chemical Society Burlington House, Piccadilly, London, W 1 (May 15)

ASSISTANT LECTURER IN THE DEPARTMENT OF CIVIL ENGINEERING—The Registrar, The University, Liverpool (May 28)

READER IN INDUSTRIAL HEALTH—The Secretary of University Court, The University, Glasgow (June 1)

SHILTO READERSHIP IN ASSYRIOLOGY—The Registrar, University Registry, Oxford (June 9)

UNIVERSITY CHAIR OF BACTERIOLOGY tenable at University College Hospital, Medical School—The Academic Registrar, University of London, c/o Richmond College, Richmond, Surrey (September 24)

ENGINEER to the Ipswich Dock Commission and the Harwich Harbour Conservancy Board—The Clerk and Solicitor to the Ipswich Dock Commission, Old Custom House, Ipswich

LABORATORY ASSISTANT (man or woman, Grade I) IN THE DEPARTMENT OF ZOOLOGY—The Secretary, Bedford College for Women, Regent's Park, London, N W 1

POSTS on the RESEARCH STAFF of the BRITISH COTTON INDUSTRY RESEARCH ASSOCIATION (candidates must possess at least a good Honours Degree and be trained in Chemistry, Physics, Engineering Physics or Mathematics)—The Director of Research, Shirley Institute Didsbury, Manchester 20

LECTURER IN METALLURGY in the Coventry Technical College—The Director of Education, Council House, Coventry

LIBRARY ASSISTANT—The Institution of Automobile Engineers Research Department, Great West Road, Brentford, Middlesex

ASSISTANT SECRETARY (male)—The Secretary, Empire Cotton Growing Corporation, 37 Inner Park Road, Wimbledon, London S W 19

REPORTS and other PUBLICATIONS

(not included in the monthly Books Supplement)

Great Britain and Ireland

Eire Romn Talmhaiochta (Department of Agriculture) Brains Iascaigl (Fisheries Branch) Statistics of Salmon, Sea Trout and Bels captured during each of the Years 1943, 1941, 1939, 1937, 1935, 1933, 1931, 1929 and 1927 (P No 6745) Pp 20 (Dublin Stationery Office, 1945) 6d

The Knights of St George, a Scout Movement for Men and Women an Educational Scheme to make Peace more Glorious than War By W Margre Pp 32 (London The Author, 9 Tyrrell Road S E 22, 1945) 1s

Quarterly Journal of the Royal Meteorological Society Supplement to Vol 71, 1945 Report on the Phenological Observations in the British Isles from December 1943 to November 1944 By Majo H C Gunton Pp 32 (London Royal Meteorological Society 1945) 3s

The Content of the Science Curriculum in Post-Primary Schools Interim Report of a Sub-Committee of the Essex Science Teachers Association Pp u+14 (Chelmsford Mid-Essex Technical College 1944) 6d

Other Countries

Astrographic Catalogue 1900 0 Sydney Section, Dec -51° to -65° from Photographs taken at the Sydney Observatory, New South Wales, Australia Vol 17 (with Plate Constants for Vols 1 to 16) R A 0h to 6h, Dec -55° to -57° Plate Centres Dec -56° Pp vi+24 Vol 19 R A 12h to 18h, Dec -55° to -57° Plate Centres Dec -56° Pp u+70 (Sydney Government Printer 1943-1944) 2s

Solcoronas Hydromekanik og dennes Forhold til Uroen på Solen o Solpletterne Av K G Meldahl Pp 16+17 plates (Stockholm A-B Nordiska Bokhandeln Forlag, 1945) 2s

University of Bombay Department of Chemical Technology Annual Report 1943-44 Pp iv+28 (Bombay The University 1944) 1s

U S Office of Education Federal Security Agency Vocational Division Bulletin No 228 (Vocational-Technical Training Series No 1) Vocational-Technical Training for Industrial Occupations Report of the Consulting Committee on Vocational-Technical Training appointed by the U S Commissioner of Education Pp xxi+306 (Washington, D C Government Printing Office, 1944) 40 cents 6d

NATURE

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SCIENTIFIC METHOD IN GOVERNMENT

THE Riddell Memorial Lectures entitled "The Unknown State"*, delivered before the University of Durham by Lord Eustace Percy, represent a noteworthy plea for the study of government. They are indeed partly addressed to the scientific worker, and were delivered in the belief that a revival of the neglected study of government is the most urgent need of the present day, and that universities have a special responsibility to make it a learned study. Whether that responsibility can rightly be placed upon the universities is a matter of opinion, but no one who has considered Sir Ernest Barker's views on this problem of government, or J T MacCurdy's suggestive chapters in "The Structure of Morale" or has noted the difficulties into which the administration is being continually led from the Cabinet level downwards for lack of attention to the fundamental machinery of government, can doubt the need for critical inquiry if not independent research in this field, or that such inquiry should be entrusted to an institution of the independent and academic type. The problem appears to lie outside the field of the National Institute for Social and Economic Research, and there is no obvious independent body to which its study could be entrusted.

At the outset of his first lecture, "The Decay of Political Thought", Lord Eustace Percy challenges the indifference of men of science to this problem. He insists that by neglecting it they imperil that freedom of movement, of entrance, and of experiment which they vigorously claim. Having won freedom, man cannot discard philosophy and remain free. His freedom depends upon the constant re-interpretation, in response to changing circumstances, of three fundamental affirmations: that there exists in any human society an authority entitled to over-ride the will of its individual members, that its individual members have, nevertheless, rights which this authority is not entitled to over-ride, and that both authority and individual have positive duties by the punctual performance of which alone the balance of their respective rights can be preserved. The most characteristic symptom of our intellectual failure during the last twenty-five years in Europe and in America to face the implications of freedom has, Lord Eustace suggests, been our attempt to escape from the study of government into the study of some vaguer entity called 'society'. The assumption that human society is either a self-evident entity like the human body, or has been ascertained to be an entity by investigations of its structure as thorough as those of the astronomer or the physicist, is false. Every science which is concerned with the study of individual man is a social science, in the sense that man is a gregarious animal, but in any other sense, Lord Eustace Percy claims that there is only one social science—political science, he regards 'social' medicine, 'social'

* The Unknown State: a Plea for the Study of Government by Lord Eustace Percy (University of Durham Riddell Memorial Lectures) Pp 48 (London: Oxford University Press, 1944) 2s 6d net

biology, for example, as merely those aspects of medicine or biology of immediate concern to governments.

Political science is the study of human beings living in a particular kind of association, called a State, whereby they regulate some part of their conduct in obedience to rules enforced upon them by persons selected for that purpose, in accordance with procedures laid down beforehand. The distinguishing mark of the citizen is that he is the object of regulated compulsion to social behaviour, while the free citizen is distinguished not only by the acceptance of such compulsion but also by sharing, in greater or less degree, in its exercise. Moreover, while the historian must always remember that manhood and womanhood are more wonderful than citizenship, and that men are greater than their institutions, he must not turn truth into falsehood by supposing that they are more social than their institutions.

Lord Eustace Percy then points out that in studying the State we must face the implications of the moral contrast, because the human law of the State does not coincide with the divine law of love. The difference between Christian and civic duty is one of consistent temper rather than of occasional practice. The central assumption of English-speaking democracy is that the citizen must not only be ready to resist general social disorder; he also must think instinctively, even of offences against himself, not as personal injuries, but as threats to the safety of his neighbours. He is not entitled to forgive, and where this civic temper fails, free government breaks down.

Lord Eustace Percy's analysis up to this point shows clearly how easy is the transition from freedom to anarchy, incessant vigilance, clear thinking and a real attempt to grapple with the philosophical aspects will be imperative in addressing ourselves to the tasks of social reconstruction. The divorce of compulsion from responsibility may yet prove the factor to wreck a social security scheme or a full employment policy. Reformers, as he wisely says, can dispense with a philosophy of government only so long as the citizen feels that he is being reformed by his own consent. Once our old catchword of 'government by consent' ceases to describe the citizen's real feelings, he will turn by instinct and tradition from those who govern him to those who offer to govern him on intelligible principles for definable purposes. These principles and purposes must be religious, based upon a coherent view of what man is, of what constitutes for him a 'good life', and of the means by which it can be attained, and in this second lecture, Lord Eustace Percy outlines a Christian philosophy of government. What matters primarily is the spirit of a government and of its citizens, and the practical difficulties are considered of preserving this spirit in a reforming democracy which is also a great international Power.

The statesman, it is pointed out, must work in the medium of social circumstance. Remembering that his fundamental aim is moral improvement, he must judge the probable moral effect upon his citizens, both of law itself and of the processes by which law is made and enforced, given the character of his citizens, the texture of their social system and

the machinery of government at his command. In governing backward peoples, he must be careful not to distort, by novel constraints, the human nature which he can compel, but cannot suddenly change. Compromise is to the statesman what the scientific method is to the man of science; but in politics this scientific attitude has proved unstable.

Christian positivism, Lord Eustace Percy suggests, needs the thought and teaching of universities. Their social surveys at present are providing material for the administrator, not for the statesman, and reflect the contemporary preoccupation with urgent administrative projects, from which emerges no outline of settled law. In his final lecture, he attempts to outline the practical application of his Christian positivism. Here he suggests that under modern conditions of publicity, the tendency of law to create superstitions, and, in its turn, to be itself progressively influenced by such superstitions, has become an imminent danger to the whole system of parliamentary democracy. We need, particularly now, to submit our inherited laws of personal relationships to criticism as keen, and as closely related to the actual facts, as that which Bentham brought to bear on the inherited legal systems of his day, remembering that virtue is a more important fact than vice. The art of government lies, not in continual accretions to law as circumstances or fashions of thought seem to demand, but in those transformations of essence by which the body of the law is kept sound and is made serviceable to the good citizen.

Lord Eustace Percy refers to the point that the only interest which the law recognizes in the shareholder is that of current profit, and in passing to the problem of fitting policy to the facts, he is equally forthright in his challenge to political invention. He emphasizes the danger which lies in the identification of government with the social services, a belief in the efficacy of taxation, and in the efficiency of pure State administration. After the War, a social service policy must, at least, be one of the priorities such as housing, and careful selection. But we must remember that a legislative minimum tends to become a social maximum, and Lord Eustace Percy hopes for the recognition of the family rather than the individual, as the unit of social reform, though it involves a reconsideration of law, a reconstruction of administration, and a regeneration of the spirit of State policy.

In conclusion, Lord Eustace Percy refers to the necessity of overcoming that disabling weakness in the local administration of Britain—the growing inability to combine State and voluntary social services. The most urgent duty of government at this time is that of mobilizing all citizens in the tasks of reconstruction. We have, moreover, to find a way of carrying out social reconstruction without turning every general election and every parliamentary debate into a competitive appeal to majority self-interest. The future task of all law and all statesmanship is to convince men of the inevitability of social change and of its inevitable effect on all lives, to draw from them, in that conviction, the 'free-will

offerings' which alone can bring us safely through such change, and to adapt law and administration fearlessly to such change. Government, like marriage, is a great adventure, but, like marriage, an adventure in the normal architecture of a common life whose temper and whose end is peace, and to both of which the temper of crisis is fatal.

It is remarkable how similar is this philosophical approach in some of its conclusions to those reached by Prof H J Laski from an entirely different angle in his pamphlet, "Will Planning Restrict Freedom?"* Prof Laski argues that planning will be required not merely to renovate the tragedies of war but also to inaugurate that era of scientific research on the threshold of which we stand, and that to give effective expression to the public context in housing and health and nutrition and education, society must plan the use of its resources in peace not less than in war. He examines the argument that in a planned society the citizens must lose that chance to experiment with themselves which is the essence of freedom. Planning, he points out, is simply the exercise of that foresight which adapts the means to the end, but planning evades the dangers of bureaucracy only when the decisions taken by the professional planners are built upon an alert and interested public opinion. A planned society requires from its citizens a higher degree of knowledge, and a far greater continuity of interest than are required in a State where *laissez-faire* obtains, and Prof Laski quotes the experience of the Tennessee Valley Authority which D E Lilienthal brought out so strongly in his recent book.

Prof Laski is thus on common ground with Lord Eustace Percy in urging that decentralization, participation, and a high level of social understanding are the essential safeguards against the danger that a planned society may degenerate into bureaucracy. Decentralization prevents the impress of uniformity in a world where variety is essential for the realization of any scheme of values, participation enables ordinary men and women to play their part in the civic process, instead of leaving their experience to be inferred by leaders. A high level of social understanding is important, first as preventing the division of any society into a small number of persons who rule and a vast multitude over whom they rule, and, secondly, because those who lack a map of the universe in which they dwell are liable to lose their way.

Our task, as Prof Laski sees it, is to discover the institutions through which decentralization, participation, and a high level of social understanding are made generally available to ordinary men and women and he points to three types of experience of which our historic freedom has been the outcome, and which are closely connected with these safeguards against bureaucracy: our emphasis on local self-government, our long experience of ecclesiastical self-government, and, in the last century, our experience in the trade unions and the consumers' co-operative movement. All these point to the existence of a considerable reserve of unused talent, and

it may well be that the joint industrial councils and production committees will provide a potent means of expression in the future which will facilitate that closer integration of industry with the community which is one vital aspect of our problem.

Prof Laski's approach is more pragmatic than Lord Eustace Percy's, but the trend of thought is strikingly parallel. Prof Laski emphasizes the necessity, in developing a system of government, of delineating clearly the responsibility for decisions and of avoiding building institutions which provide ministers and officials alike with an excuse for not taking action. Again, he insists on the need for a massive publicity over the whole field of social action, and on the danger in the assumption by a vast majority of the citizens that political responsibility is not a task in which they ought to share: they must be brought to realize that it is, on the contrary, an integral part of their civic function to shape the character of the political process into which they are born. Once again we find the recognition that, important as is high ability in politics, it is only likely to achieve its appointed aim when linked with integrity and courage.

The central issue in planning is that of eliciting the maximum possible participation of the body of citizens in the processes of politics, and reviewing measures and changes required in the transformation to a planned society. A planned society involves the acceptance of a common body of purposes by its members, and an equal response to equal demands. In saying this, Prof Laski comes closer to Sir Ernest Barker's postulates for democratic government, and to the extent that the totalitarian State represents the spirit and temper of intransigence rather than the spirit of accommodation, Prof Laski might dispute its claims to be a planned society. But there can be no question that in war-time the most successful administrators have been those who most fully took their subordinates into their confidence and sought both to elicit and to use the experience of those subordinates. Firms which had a tradition of good relations with the trade unions have almost invariably a better record of production than firms with a tradition of bad relations. That experience is highly relevant to the future organization of industry, for in industry as in other fields, it remains true that nothing is so important in a society which seeks to remain democratic as the ability to maintain a high interest in its problems among the body of its citizens; and nothing so promotes that high general interest as the pursuit by the community of great purposes which call for the participation of the common man.

Prof. Laski may be rather too facile in his argument, but his pamphlet stresses the essentials clearly enough, though he does not throw down the same challenge to creative thought as Lord Eustace Percy. Without such creative thought, however, we are unlikely to evolve the machinery necessary to serve the needs and purposes of a society determined to achieve the Four Freedoms, and it can at least be said that this pamphlet, like others in the same series,

* Will Planning Restrict Freedom? By Prof Harold J Laski (The Planning Bogies Series) Pp 40 (Cheam Architectural Press, Ltd, 1944) 6d

is a contribution to constructive and unprejudiced thinking about the real issues. The argument, though not the philosophy of Lord Eustace Percy's lectures, has been stated fairly enough often before. It was well put in J MacMurray's "Constructive Democracy", for example, where not only the necessity of government in a true democracy being under effective control was urged, but also the necessity of achieving industrial democracy in order that political democracy may survive. It may be true that, as MacMurray urges, the exclusion of the economic life from the competence of the political authority does not belong to the essence of democracy. Freedom of culture is, however, of the essence of democracy, and while conferences such as those recently held by the British Association and the Association of Scientific Workers show how men of science have awakened to the social implications of their work and are increasingly ready to recognize their responsibilities as citizens, the challenge to fundamental thought about the institutions of government, untrammelled by party inhibitions or tradition, thrown down directly and by implication in these papers is one which they, no less than others, have yet to meet.

THE FRAGMENTATION OF SCIENCE

Mitosis

The Movements of Chromosomes in Cell Division. By Prof Franz Schrader. Pp x+110 (New York: Columbia University Press, London: Oxford University Press, 1944) 13s 6d net.

TWENTY years have passed since the appearance of Wilson's "Cell", that is of the third and all-embracing 1,200-page edition of this work. We may indeed take 1925 as the end of an epoch, the epoch of comprehensive description, always painstaking, usually thorough, and sometimes otiose, description. In the end this method collapsed of its own weight and broke into pieces. Since 1925 we have been busy putting the pieces together. There are many ways of doing this, most of them unprofitable, but some of them have given new structures of a kind not previously known in biology. Such, for example, is the genography based on the union of breeding analysis, X-ray breakage and salivary gland mapping. On the purely cytological side there is also the speculative structure based on a few simple observations of meiosis in polyploid plants, a structure on which we have been able to rest all our knowledge of genetic crossing-over as well as a large part of our knowledge of chromosome mechanics at meiosis and mitosis. Other special theoretical structures are arising, or will arise, from the new experimental methods of ultra-centrifuging, X-ray breakage, ultra-violet absorption spectroscopy, micro-incineration, specific enzyme treatments, and so on.

Such are the circumstances in which Prof Schrader, Wilson's successor, takes up his pen to continue the work. Prof Schrader, like his predecessor, is technically equipped for his task by a long and careful study of mitosis in certain Hemiptera. Theoretically he is equipped by his understanding of the change that has come over this field of research. He values highly the power of concentration in attack which the achievements of the last twenty years have

demonstrated. His theme is mitosis, the division of the cell and the nucleus. In treating it he has taken great pains in limiting his objective and avoiding side issues. He has relegated the resting, prophase and telophase nuclei to a chapter of notes at the end of the book. He has likewise excluded the peculiarities of meiosis from his argument, and the evidence from sex-chromosome behaviour, which he himself summarized in 1928, and which a less self-denying critic might have been tempted to consider is now grown too bulky or too awkward to take into account. The abnormalities of mitosis produced by cancer and by colchicine and X-ray treatments are sacrificed to the same economy. The uniformity of plants and the diversity of Protozoa (and here we may perhaps cavil) find no place. Genetics, chemistry and internal structure are all locked out or, one should say, thrown away, for they surely contain something of value for the study of mitosis.

After this generous clearance there is little left to distract us from the residue. This is simply the mitotic spindle and the centromere by which the chromosome is attached to this body, both of them stripped of their most significant variations. How does Prof Schrader deal with this residue? Old-fashioned writers, like Wilson, have faced the same problem. They have first said what happened in mitosis, how it varied in Nature and could be changed in experiment, and have then drawn the conclusion and expounded the theories that seemed to combine or clarify these conditions. Schrader's method, however, is a new one. Having established the 'reality' of the spindle fibres as a basic assumption in two pages, he goes straight to general theories. The inevitably *a priori* theories of forty, fifty and sixty years ago occupy most of his attention, but the young ones also get their turn until liquid crystals and tactoids are reached. Throughout the discussion observations and experiments appear only as the casual commentators, supporters or objectors, called in apparently to rectify the balance where some theory seems to be showing too badly or too well. For Prof Schrader is utterly impartial. If one theory is obviously useless it is admitted to have helped in its time, and if another theory is obviously sound it is degraded to a truism or a mere exaggerated fact.

With such a tale the end would be foreseen, even if the author had not stated it on the first as well as on the last page. It is that his inquiry after the perfect and ultimate theory has failed. Mitosis is still too complicated, and the assault still too diffuse, for success. He feels "confusion", "humility", "disillusion" and a "despair" tempered only by hope that still further concentration in the attack (or should he say, fragmentation in the objective?) may yet yield "definite promise of a final solution".

Prof Schrader's book may seem depressing, and especially to those who know the merit of his purely descriptive work. But it is not entirely without value. It contains the lesson that while specialization in technique and material is necessary and profitable specialization in theory, an arbitrary restriction of data, is a contradiction in itself. It is like mountain eering in manacles. That is why this book, on an immense subject, peters out into notes and trifle after seventy-five pages. In describing the past, and planning the future, of scientific theories we must consider all things before we choose to adopt or reject any of them, and in order to make that choice we must have a point of view, and perhaps even a theory, of our own. C. D. DARLINGTON

INDEXING THE HYDROCARBONS

Faraday's Encyclopedia of Hydrocarbon Compounds
Compiled by Dr Joseph Escott Faraday Vol 1
C₁ to C₆ Pp xxv+47+92+40+104+103 (Manchester · Chemindex, Ltd, 1945) £7 10s 0d

FOR many years past organic chemists have been making and describing in detail thousands of new organic compounds it was and is essential that a worker should know what had been done previously to his discoveries. The advent of Beilstein's handbook had a profound influence on progress when it appeared well over sixty years ago, for it enabled quick reference to the literature. Later it was supplemented by Richter, at first a private enterprise, but later taken over by the German Chemical Society, which created a considerable organization to keep it up to date. British chemical journals and *Chemical Abstracts*, like the corresponding American and German publications, have since contained a formula index on the Richter plan. Decennial indexes have been produced. Yet in spite of all, the magnitude of the task is so great that everything is decades out of date: the two long wars have contributed to the chaos. Now Dr Faraday will make a fresh start—less ambitious, because it confines itself to the hydrocarbons, and presented in loose-leaf form so that an annual issue of new sheets will keep it up to date either by inserting new pages or substituting new matter for old.

The choice of hydrocarbons is both indicated and happy, for they stand to-day in the forefront of chemical interest as bricks for further synthesis. It is sought to give for each both a wide range of physical properties and every known method of preparation.

The first volume deals with compounds containing from one to five atoms of carbon. Its price is £7 10s, which is reasonable in regard to present-day costs, but obviously restricts possession of the book to firms and university libraries. A larger sale than has been estimated would no doubt reduce the cost, and we are inclined to recommend that it be considered an obligation on the part of all firms who make use of hydrocarbons to possess a copy. The time saved by its use can be very considerable, and every chemical unit must carry its share of the burden of producing chemical literature. Up to now this burden has been very unequally distributed and has fallen on the shoulders of far too few loyalists concerned with chemical progress.

Reference to the book is quick and easy, the sheets relating to a particular compound are numbered in order, formula and alternative names are clearly given. Taking C₆H₁₀, trimethylethylene, as an example, eighty-one methods of preparation are given on six sheets, with references to the journal in which each of these is found. The nomenclature adopted naturally follows very closely the International Rules for naming Organic Compounds.

The Germans in the past have used their hold in scientific literature to propagate the doctrine of German supremacy in chemistry which it has proved so hard to destroy, not so much among chemists, who were aware of the falsity of the claim, as among the intelligent public and the financiers in the City of London, who would often accept an invention, however incomplete or spurious, brought them by a foreigner but would rarely listen to a British inventor. These pages of our credulity must be closed for ever, British inventions are best must be our slogan. We must produce and finance our own literature and not

be afraid to proclaim our own achievements. The secrecy imposed by the censorship to-day is a blight on progress, but it is small in comparison to that imposed by firms on their doings. How many know that the first magnesium from sea water was made in Britain and not in America? Surely this was a chance to tell the world of a British achievement.

In our opinion Dr Faraday has made a start on a project which deserves widespread support, if we fail him, then the chemical industry of Britain deserves to fail also.

E F ARMSTRONG

PLANT ROOT DISEASES

Root Disease Fungi

A Treatise on the Epidemiology of Soil-borne Disease in Crop Plants, and a First Exposition of the Principles of Root Disease Control. By S D Garrett (*Annales Cryptogamici et Phytopathologici*, incorporating *Annales Bryologici*, edited by Dr Frans Verdoorn, Vol. 1) Pp xiv+177 (Waltham, Mass Chronica Botanica Co., London Wm Dawson and Sons, Ltd, 1944) 4 50 dollars

TO the plant pathologist, at work on a root disease, there quickly comes a realization of the enormous complexity and essentially dynamic nature of his problem: the soil, its organisms, and their vagaries make a whole world. But it is a world susceptible to the methods of science, and already, in some instances at least, results based on exact observation and carefully controlled experiments have been obtained, in other instances, because of the incompleteness of experience and the insufficiency of precise data, the subject is at a more elementary stage.

As the sub-title indicates, the author has undertaken a not inconsiderable task. The many and varied aspects of root infection and of the spread of fungal pathogens in the soil have been faithfully dealt with, so, too, the effect of temperature, moisture content, texture, organic content and soil reaction upon parasitic activity are considered in detail and clearly set forth. The latter part of the book is devoted to the ascertained facts relating to the control of root-invading fungi. It may be noted that the author has not considered it within the scope of this volume to deal with the related problems of root physiology and ecology.

There can be no doubt that this work represents a close and fair review of the literature, which is extensive. As an up-to-date survey of work in a field in which he has special experience, Mr Garrett has written a book which should be of very considerable use to all engaged on the investigation of soil-borne diseases.

Due prominence has been given to the specific conceptions of this branch of botany. The author of a work such as this is necessarily limited by the contemporary state of knowledge. Because of the extensiveness of the subject and the relatively restricted number of workers engaged on it, much of the research, on the fungi of tropical soils for example, is still at an early stage of development. Generalizations based on existing knowledge must therefore be accepted with due caution.

Since the work aims at an exposition of principles, and since the subject-matter is by its nature somewhat discursive, brief summaries at suitable points would have added to the usefulness of the book by rendering it more incisive.

C W WARDLAW

RELATION OF CRYSTALLOGRAPHY TO CHEMISTRY

By DR. A. F. WELLS

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IN the development of chemistry two phases can be distinguished. First there is a subdivision into more or less self-contained sections, inorganic, organic and physical—a subdivision dictated by the increasing complexity of the subject. Corresponding divisions have taken place in the other natural sciences, and the training of scientific workers has become more and more specialized. In the second phase the gulfs between the different sciences and between the branches of a particular science tend to be bridged by theories and new techniques. For example, the foundations of modern chemistry were laid when physicists investigated the passage of electricity through gases and the emission of radiation from heated bodies, studies which eventually led to the modern theory of the structure of the atom. Just as the quantum theory contributed to the development of chemistry as well as physics, so within chemistry itself the techniques of the physicist and the physical chemist are required by the inorganic and organic chemist. Thus although the various branches of chemistry have separately become more complex, they have now much in common as regards theory and technique.

In relation to chemistry the science of crystallography occupies a special position. Classical crystallography was restricted to the study of the external forms of crystals and their physical properties, though the study of crystals naturally led to speculations concerning the fine structure of matter, with the result that much of the space-group theory required in X-ray crystallography was available long before it was possible to use it. With the discovery (by physicists) of the diffraction of X-rays by crystals the whole status of crystallography was altered. From being essentially a descriptive subject, of comparatively little importance to chemistry, it gave rise to a new technique making possible the determination of the spatial arrangement of atoms. Moreover, the new structural crystallography is not limited, as was classical crystallography, to the study of well-developed crystals, for its methods may be applied to powders, to quasi-crystalline materials in which there is only partial ordering of the atoms, and even to glasses and liquids. It has become customary to describe that part of the new knowledge which is of more chemical interest as 'crystal chemistry', while 'crystal physics' embraces the study of the physical properties of crystals and their relation to internal structure. In this article I shall endeavour to show that the subject-matter of crystal chemistry is of such fundamental importance to chemistry that it must be incorporated into chemistry as an integral part of that subject.

The question of the relation of crystallography to chemistry is not only of academic interest. It is intimately concerned with the practical problem of how chemistry should be taught, and the type of training determines the mental outlook of chemists and hence the way in which the subject develops. Certain practical advantages of a knowledge of crystallography are sufficiently evident, for example, the ability to recognize crystalline forms in microchemical

analysis and to identify solid compounds by means of their refractive indexes. The recent publication of a book on the optical properties of organic crystals is a sign of the increasing attention being paid to the use of crystallographic data for such purposes. We still await a systematic compilation of morphological data such as was envisaged many years ago by T. V. Barker. Indexes of optical, morphological and X-ray data represent three ways in which crystallography can be of immediate practical value to chemists. The ability to 'think in three dimensions' and the appreciation of the relative shapes and sizes of groups of atoms are invaluable to those designing molecules of particular shapes required, for example, in modern synthetic polymer research.

We might make two generalizations about chemistry which illustrate the artificiality of separating crystal chemistry from chemistry. The first is that the chemist is chiefly interested in reactions between atoms, ions or molecules of different kinds, and the second is that so far as structural studies are concerned he deals only with finite groups of atoms. These limitations arise from the very nature of chemical methods and illustrate two essential differences between chemical and physical methods of studying a substance. The chemist studies it by changing it into something else, that is, he investigates how it reacts with other substances, the nature of the products, the mechanism of the reaction, and so on. Furthermore, he can deal only with substances in the liquid, dissolved or gaseous states, in which they exist as finite molecules or complex ions. When, therefore, an indefinitely large grouping of atoms has been formed, it can be studied only by breaking it down into smaller fragments which can then be examined by these chemical methods. The physicist, on the other hand, studies the way in which matter interacts with energy in some form or other without, in general, causing any irreversible change in composition.

In certain cases the chemist is interested in the combination of atoms of the same element, for example, when they form a finite molecule (Cl_2 , P_4 , etc.), and the determinations of the numbers of atoms in these molecules were essential to the assignment of correct atomic and molecular weights. The cohesion of such molecules in the solid and liquid states involves only interactions of a feeble sort between the electronic systems of molecules within which the primary chemical valencies of the elements are already satisfied, that is, the crystal is built up of discrete molecules held together by van der Waals bonds. There are, however, other possibilities. For example, an element may form finite molecules in solution or in the vapour state, but further combination, by means of the same kind of bonds, takes place on crystallization, giving infinite arrays of atoms as in crystalline selenium (infinite chains) or black phosphorus (infinite layers). Some elements, indeed, have two crystalline modifications, one of which is built of finite molecules and the other of infinite 'molecules', as in the case of white and black phosphorus. In yet other cases there is no stable finite molecule, as with carbon and silicon. Not only similar atoms, but also similar molecules may join together to form more complex molecules. Where the latter are finite, the reaction comes within the province of chemistry, where infinite, the polymer is a solid. Thus molecules such as Fe_2Cl_6 and Al_2Cl_6 simply represent degrees of molecular complexity intermediate between the molecules AX_3

and the infinite 'molecules' in the solids. The formation of these intermediate molecules is the exception rather than the rule. As an example of another type of combination between similar molecules we may instance the dimeric forms of certain carboxylic acids. Here the two molecules are held together by hydrogen bonds of exactly the same type as hold together the molecules in the crystal. Just as there are two ways of building up an infinite array of molecules of oxalic acid by means of hydrogen bonds into infinite chains and layers in the two crystalline forms, so in other cases there may be two ways of uniting the molecules, to give on one hand a finite dimeric molecule and on the other the infinite array in the crystal. These examples should suffice to show that the comprehensive study of the interaction between atoms and molecules includes all cases of combination, whether the primary units be atoms or molecules of the same or of different kinds, and whether the product is a finite or an infinite grouping. We must now indicate other ways in which the study of the solid state has enlarged the scope of chemistry and contributed to our understanding of matters essentially chemical.

By enabling us to study atomic arrangement in the infinite arrays of atoms in crystals, X-ray crystallography has greatly extended the range of stereochemistry, a subject which hitherto had been restricted to the study of finite molecules and complex ions. We have already remarked that in order to study a substance by chemical methods it is necessary to use it in solution or in the vapour state, that is, to break down the extended groupings of atoms characteristic of the crystal into finite molecules or ions. Thus the information obtained from the study of the solid state is complementary to that provided by chemical methods, though the stereochemistry of finite molecules may also be studied—and with greater precision—in the crystal, for in molecular crystals the internal structure of the molecule is in general not appreciably affected by the relatively weak intermolecular forces. We may remark here that the physical methods have an important advantage, apart from their greater precision, over the chemical methods, in that they do not depend on deductions concerning the mechanisms of reactions, a complication inherent in the classical methods of studying stereochemistry. The study of crystals has had much less effect on organic than on inorganic chemistry, for a number of reasons. First, the structural units in crystals of the simpler organic compounds are generally the same finite molecules which are studied by the chemist. Second, most organic compounds are built from atoms of a small number of elements (carbon, nitrogen, oxygen, sulphur, hydrogen and the halogens), so that when the approximate disposition of bonds from these elements was known the rough configuration of quite complex molecules could be deduced. The third point is that relatively few complete crystal structure determinations of organic compounds have been made.

Inorganic chemistry, however, presents a very different picture. Not only have we to deal with a very large number of elements, but also there is the additional complication that many of them do not form molecules or complex ions amenable to study by the methods of classical stereochemistry, which required the preparation of molecules or complex ions exhibiting stereoisomerism or optical activity. Whereas, for example, the arrangement of bonds round a silicon atom had to be deduced from the

optical activity of a compound such as $(C_2H_5)_3(C_3H_7)_2Si(CH_2C_6H_5)(CH_2C_6H_4SO_3H)$, and whereas the evidence for a particular arrangement of bonds might be only the feeble optical activity of a single compound, the stereochemistry of an element is often established with certainty by the analysis of the crystal structure of a very simple compound or of the element itself. Thus the tetrahedral arrangement of the four bonds from a silicon atom is evident from the structure of the crystalline element, and the planar disposition of the four bonds formed by divalent palladium or platinum is proved by the crystal structures of the chloride ($PdCl_2$) and sulphide (PtS) respectively. Since detailed crystal structure determinations have been made of many more inorganic than organic compounds, the whole aspect of the structural side of inorganic chemistry has been changed.

The effect of studying the spatial arrangement of atoms in crystals has been much greater, however, than simply to extend the subject-matter of stereochemistry and to make its data more precise. The detailed study of bond-lengths and inter-bond angles, together with the similar information gained by the application of other physical methods such as spectroscopy and electron diffraction, has added greatly to our knowledge of the nature of the bonds between atoms. In the realm of inorganic chemistry the study of the solid state has given us knowledge of the constitutions of many large groups of compounds which could not be studied by purely chemical methods. Prior to the development of X-ray crystallography, it was not possible to elucidate the structures of such groups of compounds as hydrates, silicates, etc., which exist only in the solid state, and the postulation of whole series of fictitious silicic acids is perhaps the best-known example of the result of making deductions about the constitutions of solids without having any knowledge of the atomic arrangement therein. The knowledge we have acquired of the principles underlying the structures of compounds of many types enables us to appreciate the limitations of empirical formulae as means of expressing the constitutions of solids. For example, the compounds calcium carbonate ($CaCO_3$), silicate ($CaSiO_3$) and titanate ($CaTiO_3$) have quite different structures, the first containing discrete CO_3^{2-} ions, the second cyclic $Si_2O_7^{6-}$ ions, while the third contains no complex ions. The recognition that not only the satisfying of chemical valencies or the balancing of charges, but also geometrical factors play a part in determining the composition of a solid leads to a fuller understanding of concepts so fundamental to chemistry as the laws of chemical combination. If a substance, whether in the solid, liquid, or gaseous states, consists of stable finite molecules, then we expect to find the law of fixed proportions rigidly obeyed. Also, in the case of an ionic crystal such as sodium chloride ($NaCl$), the requirement of electrical neutrality necessitates the presence of equal numbers of sodium and chloride ions. Although non-stoichiometric crystals can be prepared by special methods (for example, by heating a crystal of sodium chloride in sodium vapour) the departures from stoichiometric composition are very small. In the case of ferrous sulphide (FeS), however, the sulphur lattice is sufficiently rigid to tolerate the absence of some of the iron atoms, with the result that the 'FeS' phase is stable over the range 50–55.5 atomic per cent sulphur, accounting for formulae ranging from $Fe_0.8S$ to $Fe_{1.1}S_{1.2}$ assigned to natural specimens of this

material. In this connexion it is interesting that ferrous sulphide is so often quoted in elementary text-books as an example of a chemical compound, and that it figured in the controversy between Proust and Berthollet over the law of fixed proportions. In 1804 Berthollet expressed the view that "the metals can combine with sulphur in very various proportions, and the combinations which are thus formed have very different properties according to their proportions. I am, in this case, again in opposition to the opinion of Proust, who asserts that by the invariable law of proportions sulphur and iron are fixed at 60/100". It would seem fortunate that these early investigators studied the system Fe-S rather than Ni-Te, for example, in which phases with all compositions ranging from NiTe to NiTe₃ are stable. Here, however, we are nearer alloys than chemical compounds; but this only serves to illustrate another point. No definite dividing line can be drawn between alloys and chemical compounds, and alloys—particularly the 'interstitial compounds' (certain hydrides, borides, carbides and nitrides)—are notable for their variable compositions.

So far we have been considering to what extent a knowledge of the arrangement of the atoms in the interior of crystals affects our outlook on chemistry. This knowledge is, however, also essential to an understanding of the properties of the surfaces of the crystal and of processes involving the formation or breakdown of the crystal. Reactions involving a solid phase must start at the surface of the solid, and such reactions are of particular interest both theoretically and practically. The oxidation of a solid metal was one of the first reactions studied quantitatively (the increase in weight of metallic tin on oxidation was recorded by Jean Rey in 1630), but the investigation of the mechanisms of such processes is difficult, and it is only recently that much progress has been made in this field. For example, the results of studying the dependence on oxygen pressure of the semi-conductivity of oxides such as cuprous oxide and zinc oxide, and of the rates of oxidation of the corresponding metals, suggest that these phenomena are closely related. In the case of the oxidation of ferrous oxide (FeO) through Fe₃O₄ to Fe₂O₃, we can now give some sort of physical picture of the process on the atomic scale. The activity of many surfaces is well known and is made use of in a variety of ways. The properties of a surface must be accounted for, not only in terms of the properties of the individual atoms or molecules composing the surface, but also of the atomic structure of the surface, that is, the actual arrangement of atoms in the surface and the difference between the environment of a surface atom and a similar one in the interior of the crystal. The phenomena of crystal growth—the development of different habits from different solvents, the effects of impurities on the habits of crystals and more generally of the form in which a solid separates from solution, whether crystalline or colloidal—all these are associated with the properties of atoms in surfaces and with the way in which the solute interacts with the solvent. The solubility of one substance in another is evidence of interaction between the two substances, and this may be of various kinds. For example, the interaction between molecules of naphthalene and benzene or between stannic iodide and carbon disulphide is quite different from that between, say, resorcinol and water.

The term 'soluble' is loosely used in various senses in chemistry, for example, when it is said that

sodium chloride is soluble in water, ferric chloride in pyridine, mercuric iodide in a solution of potassium iodide or finally a metal in an acid. Even when no obvious chemical reaction takes place, there may be important alterations in the constitution of the solution. Thus in solid ferric chloride there are infinite groupings of iron and chlorine atoms in which every iron atom is surrounded by six chlorine atoms. If this compound is dissolved in carbon disulphide, it forms molecules of Fe₂Cl₆, as it does in the vapour at temperatures below 750°C, but in solution in pyridine the condensation 2FeCl₃ → Fe₂Cl₆ is prevented by the linking of a pyridine molecule to each iron atom. Thus in these various cases we find that 'ferric chloride' exists in quite different forms with iron atoms bonded to 6, 4 and 3 chlorine atoms respectively.

There is much more to be known about a compound, therefore, than the mode of preparation and its chemical properties. It has a structural chemistry of its own if we include within the province of structural chemistry the relations between the constitution of a substance in different states of aggregation. Finally we may mention the interpretation of data concerning processes which involve the formation or breakdown of crystals. The analysis of data such as heats of fusion, sublimation and crystallization calls for knowledge of the actual processes taking place while the crystal melts, vaporizes or is built up, in terms of the nature and numbers of bonds broken or formed.

In conclusion, we would suggest that there is no longer any justification for drawing a dividing line between finite and infinite arrangements of atoms and regarding the study of the former as constituting chemistry and of the latter crystal chemistry. The chemist has concerned himself exclusively with finite groups of atoms because he must break down the infinite groups of atoms in crystals before he can apply his chemical methods to them. The tendency to regard all compounds as existing in the form of finite molecules arose quite naturally from the study of gases, which necessarily exist in this form, and from the intensive study of organic chemistry, which is concerned with substances existing for the most part as finite molecules in all states of aggregation. If the study of atomic arrangement in the solid state had become possible at an earlier stage, the scope of chemistry would not have been limited in the way we have been discussing. We have seen that as regards inorganic compounds, although it is true that some crystals may be broken down and reformed reversibly (for example, simple salts), while with others the breakdown of the crystal destroys the chemical identity of the compound (as in the case of silicates) yet in all cases there is a wealth of information which can be gained only by studying the infinite array of atoms which constitute the solid compound. Similarly, the fact that the molecules which exist in crystal of glycine may be studied in solution is no reason for neglecting to study the way in which they are held together in the solid state. In the attack on the structures of substances of increasing complexity, from the large finite molecules such as globule proteins and viruses to the infinite 'molecules' of fibres, natural and synthetic, the chemist must rely more and more on the crystallographer. When building up a chain step by step (for example, 2CH₃I + 2Na → C₂H₆ + 2NaI) the chemist could deduce the constitution of the product. When, however, he polymerizes simple aliphatic compounds to polymers of high molecular weight, for example, ethylene to

polythene, he can no longer determine the structures of his solid products and must rely on the X-ray crystallographer to tell him what he has made. The old chemical methods of synthesis and degradation give only limited information about the structural units, and to discover how they were originally linked together is not always within their power.

COMMENTS ON CHROMOSOME STRUCTURE

By DR. I. MANTON
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WHEN a great physicist takes the trouble to explain in simple language some of his matured thoughts on topics of general interest outside his own subject, it is an event for which one cannot be too grateful. The following remarks have been aroused by the appreciative perusal of Prof. E. Schroedinger's delightful little book "What is Life?"¹

Without attempting to summarize the whole of Prof. Schroedinger's argument, it is valuable to notice the great stress which is laid on the existence of two very different methods of obtaining orderly behaviour of matter in Nature. In the inanimate world 'order from disorder' is said to be the rule; the behaviour of matter in bulk being in most cases the expression of a statistical average of the behaviour of vast numbers of particles (atoms, molecules or the like) which, individually, may be doing the most diverse things under the sole compulsion of a tendency towards increased randomness. In biological systems, on the other hand, 'order from order' is met with. In such a system the most complex sequence of events may be determined and set in motion by the pattern of arrangement in space of a comparatively minute number of individual particles occupying relatively fixed positions with regard to one another. The paramount importance of the pattern of atomic arrangement in the particular case of the genetical material carried by the chromosomes is, in Prof. Schroedinger's view, the most interesting discovery of our time.

Few biologists will probably wish to dispute this in general terms. Cytological comment is, however, aroused by the details of its presentation from the circumstance that Prof. Schroedinger, at various points, is thinking in terms of certain assumptions regarding chromosome structure which are by no means universally held. It may therefore be of interest to inquire what change of view, if any, will be entailed if these assumptions are altered.

Prof. Schroedinger is much impressed by the singleness of the 'code script' in inheritance, by code script meaning the sum of hereditary material carried by a haploid nucleus (in genetical parlance this would be referred to as a genome). That only one chromosome set or genome is actually necessary for development is clearly shown by the existence of haploid organisms, for example, many of the lower plants, or cases of parthenogenesis in both plants and animals; it is therefore quite legitimate to ignore diploidy and polyploidy. Difficulties, however, appear at once if 'singleness' is interpreted literally in a molecular sense, and that this is Prof. Schroedinger's interpretation seems clear from his very interesting discussion of the size of a gene.

It might perhaps be questioned whether the 'size of a gene' is a desirable or legitimate use of words. In its original sense a 'gene' meant nothing more than the physical basis of an externally visible mutation, and if a mutation can be caused, as Prof. Schroedinger suggests, by a change of atomic arrangement, of the nature of a quantum jump, occurring within a molecule, then a gene, strictly speaking, is the changed part of that molecule and nothing else. It is an unfortunate biological practice which Prof. Schroedinger cannot be personally blamed for following, that the word is now often used in so many extended senses that it has little precise meaning left. In discussing the maximum size of a 'gene' from genetical data, the word denotes either the smallest piece of a chromosome which can have a genetically detectable effect, or the shortest distance between two mutations which can be separated by crossing-over; a numerical estimate of either of these by existing genetical or cytological methods may be expected to yield purely subjective values expressing present crudities of technique. In discussing the minimum size of a 'gene' as deduced from induction of mutations by ionizing radiations, the word is apparently equated with the range of influence of the minimum degree of ionization required to induce a mutation. The thing that Prof. Schroedinger really wishes to discuss is the fundamental molecular unit of chromosome structure, which is not necessarily identical with any of these concepts. The use of the word gene for this also may seem particularly unfortunate to a cytologist because some idea of structural discontinuity is almost inevitably implied. Mutations are discontinuous and arranged in linear sequence along a chromosome. Whether the fundamental genetical material in which the mutations occur is or is not also discontinuous (like beads on a string) is quite another question and one which neither cytology nor genetics can yet determine. This linguistic difficulty would perhaps best be met if the word gene were deleted from the vocabulary; one of the most pregnant of Prof. Schroedinger's sentences could then be paraphrased as—"We believe a mutation to be of the nature of a quantum jump and the fundamental unit of chromosome structure—or perhaps the whole chromosome fibre—to be an aperiodic solid".

At this point the sense in which the "whole chromosome fibre" can be regarded as a unit becomes of importance. There are at present two extreme views as to this, both supported by some positive evidence. According to the one which Prof. Schroedinger is using, the whole chromosome thread is a single structure at all times, except for a limited period during prophase when it is doubled in preparation for a nuclear division. The strongest piece of evidence in support of this is the differential behaviour of certain nuclear stages to irradiation by X-rays at dosages sufficient to cause gross chromosome fracture. Assuming that the statements in the literature are correct (for example, Riley 1936²) the position appears to be that in some organisms such as *Tradescantia*³, irradiation at prophase can cause fracture of half-chromosomes (chromatid breaks) but at other stages only breakage of whole chromosomes. In interpreting this as meaning that the chromosome thread is single at all stages other than prophase it is not always realized that this singleness could be conferred by spiral structure and is not necessarily based on singleness of the genetical material.

The spiral structure of chromosomes (or perhaps more correctly the helical structure, since the geo-

metrical figure involved would, in mathematics, be termed a helix) is probably not as widely known to scientific workers in general as its importance deserves and it is still far from being fully understood even by cytologists. That the apparent diameter of a fully developed chromosome is that of a helical coil has been known since 1880⁴ for meiotic chromosomes, though owing to technical difficulty the basic facts for mitotic chromosomes have only recently been elucidated. Examples of the structure, as revealed by special treatment or in rare instances spontaneously, are shown in Figs. 1-4 for the different sorts of division in the fern *Osmunda*. Fig. 1 shows an unpaired chromosome at the first meiotic division, with four large coils. At this stage all cytologists are agreed that the genetical material is double in preparation for the second meiotic division and that in a paired chromosome genetical crossing-over between chromatids (half-chromosomes) has taken place; both chromatids, however, share a common spiral path. At

single spiral in certain of the chromosomes is perhaps also an after-effect of the irradiation, but it accords very fully with the other evidence.

The other extreme view of chromosome structure, which is becoming increasingly accepted in the U.S.S.R. and the U.S.A. and (before the War) in Japan, though in Great Britain it has been somewhat opposed, is that a chromosome is fundamentally many-stranded at all stages. If the physical basis of unitary behaviour of chromosome or chromatid can in part at least be interpreted in terms of helical structure rather than molecular structure then perhaps the chief objection to this view has been removed. An example of the type of observational evidence on which the view is based is contained in Fig. 5⁶. The specimen here is at a later stage¹ of anaphase than that of Fig. 4 and had not been subjected to X-rays. Instead it had been given the normal pretreatment with ammoniated alcohol which is generally necessary to make the spiral appear.

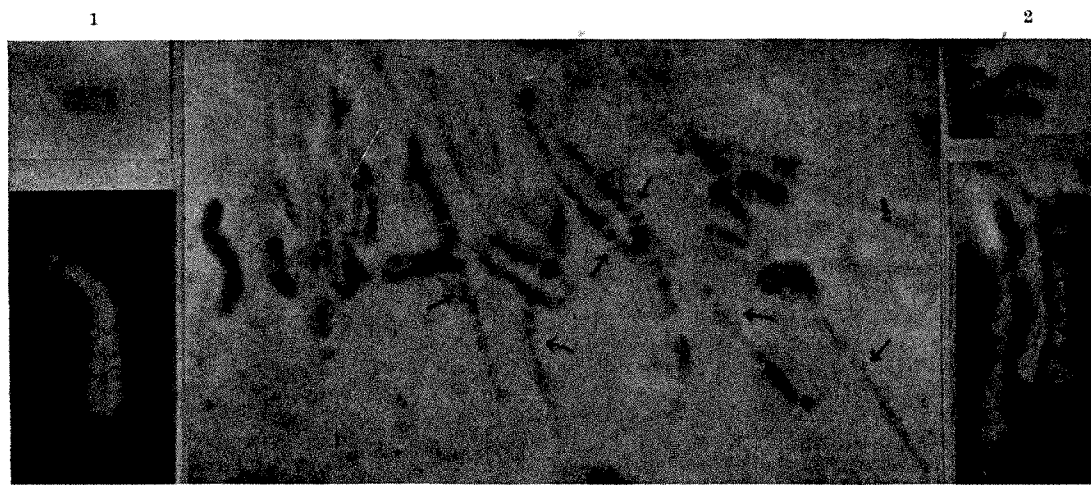


Fig. 1. Unpaired chromosome of *Osmunda* at the first meiotic division after ammonia treatment for spiral structure. Acetocarmine preparation photographed in clove oil by visual light. ($\times 2000$.)

Fig. 2. Split chromosome at the second meiotic division in *Osmunda* after ammonia treatment for spiral structure, the two chromatids are attached only at the centromere (c). Acetocarmine preparation, ultra-violet photograph. ($\times 2000$.)

Fig. 3. Split chromosome at metaphase of the third spore division in *Osmunda* showing spiral structure without special treatment. Acetocarmine preparation, ultra-violet photograph ($\times 4000$) negative print (the positive of this and others in Manton and Smiles, 1943⁴).

Fig. 4. Anaphase of the first spore division in *Osmunda* fixed 30 hours after irradiation of the uninucleate spore with X-rays at 2,500 r.* showing fractures, fusions and abnormally clear spiral structure. Acetocarmine preparation, visual light photograph. ($\times 1000$.)

Fig. 5. Anaphase of the third spore division in *Todea* after ammonia treatment. showing lateral separation of component strands. Acetocarmine preparation, ultra-violet photograph ($\times 4000$), negative print (the positive of this and other chromosomes in Manton, 1945⁶).

the second meiotic division, Fig. 2, the two chromatids diverge so widely that they are only in contact at the region known as the centromere (marked c in the figure). A new spiral, differing in diameter and in number of coils from that at the previous division, affects each chromatid. At a somatic division, Fig. 3, the number of coils is increased still further but the two chromatids lie close together. It is, however, certain that the spiral in each has been independently formed for, in the case figured, direction of coiling was determined in corresponding parts of the sister chromatids and found to be opposite⁵. There must therefore be two separate spirals during prophase and it is possibly this which is detected by the X-ray breakages. At anaphase one of the two spirals passes to each pole, and that the helical coil at anaphase is indeed single seems to follow from the unusually clear case of Fig. 4. This differs from the preceding in that it had been subjected to X-rays some hours previously and many types of fusion and fracture are displayed. The unusual clarity of the undoubtedly

The plant concerned is, however, not *Osmunda* but the closely related fern *Todea*, and the pretreatment and method of mounting acting together have in this case produced a remarkable lateral separation of longitudinally running strands. No less than four strands per chromosome are unmistakably present, most clearly countable, in the original print, in the left-most chromosome. With the detection of quarter-chromosomes the limit of optical resolution has been reached, even with light of short wave-length; but it is by no means impossible that further subdivision would be found to be present if resolution could be extended.

It is not easy to determine the diameter of an object near the limit of visibility, but the fact that quarter-chromosomes are visible at all suggests that their thickness is likely to be of the same order as the wave-length of the light used (275 $\mu\mu$). In round numbers and for the sake of argument this may be put as approximately 3000 A. Now if Prof. Schroedinger's figures for the 'size of a gene' be utilized,

ome simple arithmetic will provide a rough estimate of the possible limits of many-strandedness assuming his to exist. The higher limit for the 'size of a gene' is given as 300 A and there would therefore be room in a quarter chromosome of *Todea* for some 75 threads of this width. The lower limit of size is given as 'ten atomic distances cubed' which, for a protein molecule, might perhaps be put as of the order of 50 A. cubed. There is room in a quarter chromosome of *Todea* for nearly three thousand threads of diameter 50 A. The real unit of chromosome structure is likely to lie in between these two extremes and it is probable that allowance must also be made for some empty spaces between the strands. Nevertheless the figures, rough as they are, indicate at least the possibility that in a whole chromosome, not one but between 300 and 2,000 duplicate versions of the genetical material may be present.

This is not quite the same as the unique phenomenon visualized by Prof. Schroedinger, though it is no doubt sufficiently close to it still to come under the general heading of 'order from order' rather than 'order from disorder'. The importance attributed to atomic arrangement in the 'aperiodic solid' of the unit fibre is almost certainly correct, and this property is shared by many other protoplasmic structures besides the chromosomes, notably by enzymes. If the view of chromosome structure put forward above be correct, however, a chromosome may be found to owe some of its peculiar powers not to the aperiodic fibre as such but to the fact that bundles of these are co-ordinated together in a manner recalling, though not necessarily exactly resembling, the periodic crystals. The 'whole chromosome fibre' may in fact have to be visualized as an aperiodic solid in its longitudinal dimension but as periodic in its transverse dimension.

The recognition of an element of periodic structure in one dimension of the genetical material would perhaps be a minor emendation in the general philosophic view of a chromosome. The issues raised here, however, of immediate importance in cytology, and I trust that Prof. Schroedinger will forgive me. I have used his very interesting little book as an occasion for directing attention to them.

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ALESSANDRO VOLTA, 1745-1827

By ENG.-CAPT. EDGAR C. SMITH, O.B.E.

TO few men of science has more homage been paid than to the Italian physicist Alessandro Volta. In his life-time he was received into the highest scientific circles, and the centenary of his most important discovery and the centenary of his birth were the occasions of great international gatherings in the land of his birth. Since then, through the munificence of Signor Somani, Como, here Volta was born and where he died, has been enriched with a beautiful Volta Temple, a finely designed circular hall surmounted by a dome. This interesting building stands in the public gardens near

the edge of a lake in Como, from which can be seen the waters, the fields and woods and the mountains amidst which Volta grew up, a student and a sportsman. For centuries the family from which he sprang had been associated with the district, and its coat-of-arms consisted of a vault (in Italian, *volta*) of a silver gate on a blue background.

Volta was born on February 18, two hundred years ago, being the son of Philip and Madeleine, descendants of the family of the Counts Inzaghi. Well educated under the supervision of an uncle, Volta began experimenting in electricity as a youth, and electricity remained his one and only love. Thanks to the invention of friction electric machines and the Leyden jar, and to Franklin's epoch-making discoveries, there were scores of devotees to the study of electricity, and during the eighteenth century thousands of new experiments were performed and a mass of observations full of promise was accumulated. In the last year of the century, it fell to Volta to make one of the most fruitful inventions in the history of science. As a young man, he corresponded with such able experimenters as Giovanni Battista Beccaria (1716-81) and the Abbé Nollet (1700-70), and in 1769, at the age of twenty-four, published his first paper. In 1774 he became superintendent of schools in Como, in 1776 professor of physics there, and in 1778 professor of experimental physics in the University of Pavia, which remained his headquarters for the rest of his active career. Those early years had been marked by the invention of his electrophorus, and the suggestion of a method of long-distance signalling by electricity. But more important in his own development were his travels, during which he made a host of friends and acquaintances, and, especially in Great Britain, became familiar with the leaders in scientific thought. In 1777 his journeys took him to Germany and Switzerland, during which he met a kindred spirit in de Saussure, in 1781 he went as far afield as Belgium, Holland, France and England, and in 1782 he was in England again, and then went to Austria. In England he admired the pavements of London, the steam engines in Shropshire, and the mills at Manchester, at Portsmouth he visited the fleet under Admiral Howe. He became known to Franklin, Watt, Priestley, Laplace, Lavoisier, Van Marum and many other famous leaders in science.

Living in London at that time was Volta's countryman Tiberias Cavallo, who had come here to follow a commercial career but had succumbed to the fascination of sparks and discharges, and had published "A Complete Treatise of Electricity". To Cavallo, Volta in 1793 addressed two letters which appeared in the *Philosophical Transactions* under the heading "Account of Some Discoveries made by Mr Galvani of Bologna, with Experiments and Observations on Them". Behind this title lay a long series of trials with metals and the nerves of not only frogs, but also of quadrupeds, birds, fishes, reptiles and amphibia. Desiring to experiment on the human body, he used a piece of tinfoil and a silver spoon separated by his tongue, thus introducing an experiment which untold numbers have repeated.

In 1791 he had been made a foreign member of the Royal Society, and the Society now proceeded to honour him with the Copley Medal, Sir Joseph Banks in his address remarking, "The experiments of Professor Galvani, until commented upon by Professor Volta, had too much astonished, and perhaps, in some degree, perplexed many of the learned in various parts

of Europe To Professor Volta was reserved the merit of bringing his countryman's experiments to the test of sound reasoning and accurate investigation. . . . Just at that time Europe was in the early throes of one of her periodical upheavals, and it was partly this which had led Volta to send his memoir to London.

Seven years later came a much more important paper in the form of a letter of 8,500 words in French to Sir Joseph Banks, which ultimately appeared in the *Philosophical Transactions* under the title "On the Electricity Exeited by the Mere Contact of Conducting Substances of Different Kinds". The effect of this communication was as startling as the announcement of Rontgen's discovery of fifty years ago. The whole scientific world became agog with galvanic piles, batteries, 'crowns of cups' and so forth. For the first time electricity could be obtained in steady and continuous currents, and so was marked an era in electrical science. The fellows of the Royal Society having been enlightened, the members of the Royal Institution, just founded, of course had to be told, but unfortunately Dr Garnett, not long engaged as "lecturer and scientific secretary and Editor of the Journals", made a slip and ascribed the invention of the pile to the French, Rumford heard of this, and on May 29, 1800, wrote to Banks "I knew nothing of the matter until it was too late to prevent a mistake. I have, however, insisted on its being rectified as far as it is possible in some future lecture." Next day he wrote again that Dr Garnett is perfectly ready to atone for his lapse and will make this declaration. "Having by mistake on Wednesday, in the course of my public lecture, ascribed to the French philosophers a new and important discovery relative to galvanism, which on inquiry I find belongs to Professor Volta of Milan, I feel it my duty

The old records are eloquent of the enthusiasm about the new apparatus, and fifty years later J. D. Forbes wrote "The invention of the pile may in many respects be placed on a par with that of the steam engine. The results of the former were indeed more interesting immediately to pure science, the latter to the arts of life and the needs of civilization. Yet after half a century, this distinction can hardly be drawn with severity. The rapid pace of steam is insufficient for our needs. The electric wire conveys to its destination, ere the locomotive has time to start on its journey, tidings of joy and sorrow—life and death—of victories won, and kingdoms lost."

In the last year of the dying century, Volta was at the height of his career, a conqueror of Nature. In his native land was another conqueror, Napoleon, who in June won the battle of Marengo and so became master of northern Italy. Next year the two met in Paris. On November 11, 1801, Count Rumford wrote to Sir Joseph Banks, "At the last meeting of the mathematical and physical class [of the National Institute] the First Consul came in.

He stayed about an hour—till the meeting was over. Volta read a paper on Galvanism and explained his theory of the action of the voltaic pile or battery.

After Volta had finished his memoir the First Consul demanded leave from the President to speak, which being granted, he proposed to the meeting to reward M. Volta with a gold medal, and to appoint a committee to confer with M. Volta on the subject of his experiments and investigations respecting galvanism and to make such new experiments as may bid fair to lead to further discoveries. He delivered his sentiments with great perspicacity and

displayed a degree of eloquence which surprised me." Volta eventually got his medal and also a sum of money, and was elected a member of the Institute. Later, he became a senator of the Kingdom of Lombardy and a Count, but the world of science was enriched by no more discoveries by him.

Volta continued to work quietly at Pavia until 1819, when after acting as director of the Philosophical Faculty of the University for four years he retired to his beloved Como, where he died on March 5, 1827, at the age of eighty-two. Up to the age of forty-nine he had remained a bachelor, then he married Teresa Pellegrini, by whom he had three sons. His grave and monument are at Como, where at the great Exhibition held in honour of his memoir in 1899 a fire destroyed a great deal of his original apparatus.

One of the best recent accounts of Volta and his work is contained in illustrated articles by Mr. Frank Walker in *Engineering* of January 1938.

CORROSION OF METALS IN SOIL

THE corrosion of metals buried underground is a problem of very considerable importance, it is one also of great complexity. In 1922 experiments were initiated by the U.S. National Bureau of Standards to determine the effects of various soils on materials in general use for pipes buried in the ground. From time to time reports have been issued summarizing the results obtained as the work progressed, a report has now appeared dealing with an investigation begun in 1932 to study the corrosion resistance of both ferrous and non-ferrous materials and the effect of applying improved protective coatings*.

No attempt was made to obtain series of specimens differing step-wise from each other. Manufacturers were invited to submit specimens which they believed or hoped would be resistant. Hence the various samples differed in so many ways that co-ordination of the results is a matter of extreme difficulty. The authors have themselves realized this, and deal with their data in a thoroughly sound and logical manner. They give warning that the results must be interpreted with care partly in consequence of the difficulty of obtaining satisfactory 'repeat' results, and also because the experimental conditions were not identical with those to which pipes would probably be subjected in practice. This latter point is particularly true when protective coatings are applied because small laboratory specimens can be more carefully coated and handled with greater care than is possible in practice. As a result, when the attempt to arrive at a general conclusion of importance, it is so whittled down with exceptions and provisos as to be of disappointingly limited value. Although the detailed results will be of great value to the manufacturers who supplied the materials, upon whose behalf the research was, of course, mainly carried out, it is obviously the general conclusions that will appeal most to European readers.

Fifteen different soils were chosen, including several clays and loams, peat, muck and cinder

* Soil-Corrosion Studies, 1941. Ferrous and Non-Ferrous Corrosion Resistant Materials and Non-bituminous Coatings. By Kirk H. Loj and Melvin Romanoff. *Journal of Research, Nat. Bur. Stand.*, No. 5 (1944).

important factors mentioned are the texture of the soils, their retentiveness of water, pH values and water-soluble contents. The pH values of the soils chosen ranged from 2.6 in Rifle peat to 9.4 in Merced loam, thus covering the ambit of soils in general.

The reasons why pipes in some soils corrode more rapidly than in others have not as yet been fully determined. Soil solutions are often too weak to account directly for the observed corrosion, but the electric conductivity of soils containing soluble salts is important. Soil bacteria may also play a part. Differences of potential between various points on the surface of the material are a fruitful source of trouble, these may be due to many causes, including the presence of scale, segregations and variations in the soil itself in contact with the material in different places.

Eight cast irons were tested, including one high-alloy cast iron with 2.61 per cent chromium and 5.0 per cent nickel. The results of exposures for two, five, seven and nine years are compared, and the superiority of the high-alloy metal demonstrated both as regards loss in weight and depth of pitting. The plain and low-alloy cast irons (c. 0.5 per cent copper) with silicon ranging from 0.95 to 2.50 per cent behaved very much alike.

An interesting experiment consisted in embedding two different plain cast irons in contact in very wet loess clay, the water-soluble material of which was almost entirely sodium chloride. At first one of the cast irons was cathodic to the other, but after considerable drying of the soil a reversal took place, the anodic metal now becoming anodic. This illustrates the importance of such factors as soil aeration and water-retentiveness, as also the difficulty of forecasting results in practice in view of seasonal variations in rainfall and drought.

For many years attempts have been made to increase the resistance of steel to corrosion by alloying with different elements such as chromium, nickel and copper. In the present research, cleaned 5 per cent chromium steel, after various periods of exposure up to nine years in ten different soils, lost less in weight than ordinary steel but was more deeply pitted. Many investigators have already directed attention to this behaviour of chromium steels under quite other conditions of corrosion. The authors attribute it to formation of a protective superficial oxide film which breaks down locally, setting up potential differences leading to localized corrosion. This is a generally accepted view. On the other hand, cleaned nickel-copper steel (2.47 per cent nickel, 1.08 per cent copper) proved superior to ordinary steel both as judged by loss in weight and depth of pitting, whereas the same steels exposed with adherent scale showed no advantage after four years.

Turning now to the non-ferrous metals, a useful table is given summarizing the losses in weight sustained by nine copper alloys relatively to that of rough pitch copper taken as 100. This latter metal was very resistant to corrosion, as was also red brass (14.8 per cent zinc) and copper-nickel alloy (5 per cent zinc, 20.0 per cent nickel). The zinc content of the brasses included in this set ranged from 4.8 to 39.6 per cent (Muntz metal), and the apparent losses in weight rose steadily with the zinc content. It is pointed out, however, that in some cases the observed losses do not accurately indicate the extent of corrosion, since part of the zinc had been removed by selective corrosion which weakened the material. The observed depth of pitting also

might be misleading as in some soils dezincification occurred, the depth of which was not known. The addition of 0.08 per cent arsenic to Muntz metal did not prevent dezincification, but the authors suggest that more arsenic might yield better results.

It was noted that, in general, soils that are severely corrosive to iron may be non-corrosive to lead, the exceptions being highly organic soils. This is attributed in part to the formation on the metal surface of insoluble salts, such as sulphate, chloride or carbonate, which protect the underlying metal from attack. Organic salts, on the other hand, are usually soluble. The addition of 5 per cent antimony did not materially improve the resistance of the lead.

Copper tubes coated with a thin layer of tin appeared to receive a temporary protection, but in the course of four years much of the tin disappeared. Reversal of potential is suggested as a cause of failure, the tin being anodic and protecting the copper just as zinc protects galvanized iron. But reversal might be caused by the presence of tin-copper alloys which are cathodic.

Experiments with lead-coated steel pipes were not encouraging, the authors doubt if a lead coat of any reasonable thickness can be satisfactory in corrosive soils. On the other hand, zinc applied by the hot-dip method to the extent of some 3 oz per sq ft increased resistance to corrosion, it is concluded, however, that it would not add more than four years to the life of the pipe.

Vitreous enamel, rubber coatings, a thick moulded coating of China wood oil with mica, and a baked-on 'Bakelite' coating were each found to reduce corrosion substantially over periods of from four to nine years.

It is impossible in a brief article to do full justice to the mass of data contained in the report. The foregoing is an attempt to lay before the reader the salient features of the research.

J. NEWTON FRIEND.

OBITUARY

President Roosevelt

NOT since Abraham Lincoln was assassinated at the moment of victory eighty years ago has the death of an American president shocked the world like the passing of Franklin Delano Roosevelt on April 12, at the age of sixty-three.

Over the success and achievements of the New Deal policy which Mr. Roosevelt initiated when he entered on his first term of office as president in 1933 there is still much controversy. The policy had its faults, but, comprising economies in the public service, plans for unemployment relief, public works enterprise on a large scale, and schemes for the rehabilitation of agriculture, with the accompanying National Industrial Recovery Act, which authorized the President to frame a code of regulations for each industry, and the further legislation passed during 1934 and the first part of 1935 dealing with currency, tariff, public utilities and taxation questions, and the Social Security Act in which, for the first time, the United States accepted the principle of national unemployment insurance and old-age pensions, it nevertheless was a landmark in American history.

The full extent of Mr. Roosevelt's contribution to the New Deal policy cannot perhaps be accurately assessed as yet, though the bitterness of the personal attacks on the President made by its opponents and the determination with which he himself supported

it in the face of the judgment of the Supreme Court in May 1935 invalidating the Industrial Recovery Act and later decisions which similarly declared unconstitutional several minor but important features of the New Deal indicate that the policy owed much to the impress of his forward-looking mind. Already in the achievements of the Tennessee Valley Authority that outlook has been vindicated, and the possibility of a new and more positive conception of government demonstrated to the world. That experiment was not only a social venture but also, in a true sense, a scientific approach to the problem of the conservation and development of national resources, and the integration of local and regional administration with central government. It is an approach of exactly the same order as that which characterizes the report of the Committee on Administrative Management with which Mr. Roosevelt's name is also associated. That great State paper and the Tennessee Valley Authority are sufficient evidence of Mr. Roosevelt's appreciation of the importance of a scientific approach to the problems of government and planning, and when the dust of controversy settles down, it may well be found that scientific workers have a special reason to hold Mr. Roosevelt's name in remembrance for the way in which his determination and vision made possible a more effective contribution of science to the service of mankind, while at the same time his sense of human values never allowed that contribution to be overstressed.

While his well-known physical disability may well have increased Roosevelt's sympathy for and understanding of the less privileged people of his country, his forward-looking mind led him to seek further ways of overcoming it. In his 'fireside talks' he utilized the new technique of broadcasting with skill and success and was able not only to overcome the obstruction of Congress to measures which he regarded as essential and urgent but also to win a place in the mind of the ordinary citizen of all lands as the moral champion of freedom and human rights against tyranny and aggression. He was one of the earliest, even amid his preoccupation with the New Deal, to sense and give expression to the seriousness of that challenge to liberty, and the skill with which he used his broadcasting technique and endeavoured to express rather than lead public opinion during the first few months of the War was an important factor in securing endorsement of such successive acts in support of Great Britain and the cause for which the United Nations now stand as the setting up of a permanent joint board to consider plans for the defence of the United States and Canada, the transfer of over-age American destroyers to the Royal Navy and the lease of naval and air bases in British North America to the United States, and his great personal triumph in re-election for a third time in November 1940.

In the following year down to the Japanese attack on Pearl Harbour, Mr. Roosevelt's genius for timing was even more strikingly manifested, and the British people, and indeed the United Nations, can never forget the consummate skill with which he handled such matters as Lend-Lease, the establishment of air bases in Greenland, the dispatch of American forces to Iceland, and the amendment of the Neutrality Act. Much, no doubt, was due to the skill with which the President in his broadcast addresses and speeches voiced the aspirations of the common man and showed the way in which his policy tended to satisfy them. Even before the Atlantic Charter was drafted,

Mr. Roosevelt had showed a gift for the right and effective phrase which put some of his speeches, like those on the four freedoms and on the arsenal of democracy, alongside the Gettysburg speech of Lincoln in the literature of democracy.

On Roosevelt as a war leader the time for judgment has not yet come. Imagination has seized or the way in which this crippled leader has flown across the world to attend one conference after another. Within these years, moreover, he saw the establishment not merely of such joint agencies as the Anglo-American Combined Raw Materials Board and the corresponding Food Board, the Middle East Supply Centre, the Anglo-American Caribbean Commission, the post-war implications of which the President was one of the first to see, but also the inauguration of such definite organizations to deal with post-war problems as U.N.R.R.A. and the Food and Agricultural Organization.

It was these perhaps and the tentative scheme worked out at Dumbarton Oaks, considered further at Yalta, and now to be discussed at the San Francisco Conference that lay nearest his heart. While he did not live to see the moment of complete victory, he lived long enough to see it close at hand and to know that so far as such victory, complete, comparatively cheap, and dramatic could justify his choice of commanders, his judgment and courage have been fully vindicated. But if Mr. Roosevelt was an organizer of victory it is as one of the great architects of human liberty that he will be best remembered. We cannot measure yet what his passing may mean in inspiration and authority just as the foundations of the new world order he has done so much to plan are to be laid. Among the makers of America he will rank with Washington, Jefferson, Jackson, Lincoln and Wilson. But more almost than any of his predecessors he had the confidence of the common man, and the common man, looking back, while endorsing the verdict of the man of science that he gave science a wider opportunity to serve mankind, may well come to regard him above all as the architect of a world order in which the four freedoms are at last enshrined. Roosevelt himself would ask no more of his countrymen or of the United Nations than that they should continue to accomplish thoroughly this task to which he—and they—have set their hands. Gratitude to Britain's friend in her finest and darkest hour demands no less. "We have learnt," said Mr. Roosevelt in his Fourth Inaugural, "that we cannot live alone, at peace, that our own well-being is dependent on the well-being of other nations—far away. We have learnt to be citizens of the world, members of the human community." His infinite patience and tact and the inexorable march of events have committed the people of the United States overwhelmingly to joining some form of world organization. In a true sense he has given the world the tools and the opportunity to build again. There can be no more fitting tribute to his memory than to finish the job and to secure that the structure is adequate to the purpose to which it is dedicated.

But no tribute to President Roosevelt would be complete without reference to the help he received throughout his career from his wife, whom he married in 1905, Anna Eleanor Roosevelt, a niece of Theodore Roosevelt. To her and her four sons and daughter will be extended the heartfelt sympathy of the British people, many of whom have reason to know how nobly Mrs. Roosevelt seconded the President's efforts to aid them when they stood almost alone.

NEWS and VIEWS

Forest Products Research Laboratory

Mr W. A. Robertson

MR. W. A. ROBERTSON retired on March 31 from the position of director of forest products research (Department of Scientific and Industrial Research). He took over charge of the Laboratory at Princes Risborough in 1933, the earlier part of his career having been spent in the Indian Forest Service, mainly in Burma. Mr Robertson has thus been responsible for the direction of timber research in Great Britain during a period of important development which would undoubtedly have been greater but for the restrictions caused by the War. In 1941, when the Secretary of State for the Colonies decided to appoint a forest adviser, Mr Robertson was selected for this responsible post on a part-time basis. He will now be enabled to devote his entire attention to the problems confronting the Colonial Office in its reorganization of the Colonial Forest Service. In view of his wide experience, it may be considered fortunate that Mr Robertson's services will continue to be available in this capacity.

Dr. F. Y. Henderson

DR. F. Y. HENDERSON, who has taken up the post of director of forest products research on Mr Robertson's retirement, joined the staff of the Imperial College of Science and Technology in 1921 as plant physiologist. He devoted much of his time to research, and took an active part in teaching, and organizing the practical teaching in plant physiology. He was also for many years director of biological studies at the John Cass Institute, and superintendent of examinations for the Pharmaceutical Society of Great Britain. In 1931 Dr Henderson took over the work of Prof Percy Groom as timber technologist, and did much teaching in this field as well as research on the biological changes in felled timber.

Research in Animal Health at Aberystwyth

THE research professorship in animal health endowed by the generosity of Lord Milford at University College of Wales, Aberystwyth, has been filled by the appointment of Mr Alastair N. Worden. Mr Worden, who is twenty-eight, was educated at Queen Elizabeth's School, Barnet, the Royal Veterinary College, London, and St John's College, Cambridge. After experience of veterinary practice for more than two years with Mr J. Pickup, of Barnet, Mr Worden was awarded in 1938 a Ministry of Agriculture studentship in animal health, spending the first year of his tenure of this studentship in the Division of Nutrition of the Lister Institute, the second in the Bacteriological and Biochemical Departments of the Ministry of Agriculture's Veterinary Laboratory at Weybridge and the third in the Department of Agriculture at the University of Cambridge. He also spent some time at the Rowett Research Institute, Aberdeen. In 1941 he was appointed to the Biochemical Department of the Institute of Animal Pathology, University of Cambridge. His research has dealt mainly with human and animal nutrition and with the relation of nutrition to infectious diseases. He is a member of the Parliamentary and Scientific Committee on which he represents the Universities Federation for Animal Welfare and he is secretary of the Institute of Animal Behaviour.

Prof Worden starts with the great assets of youth, energy and the breadth of outlook which his training has given him. He goes to a centre already made famous by the work done by Sir George Stapledon and Dr T. J. Jenkin at the Welsh Plant Breeding Station at University College, Aberystwyth. Everyone will wish him success in a field which has become, as one result of the War, of great moment, not only to Britain, but also to the world in general.

Educating the Citizen

THE central problem of the planned society is, as Prof. H. J. Laski has pointed out, to make the issues at stake intelligible and to bring out in individuals the interest that compels action, in 'Planning Our Country', J. F. Adburgham and Elizabeth Halton well maintain the standard set by earlier pamphlets in this 'Unless We Plan Now' Series (English Univ Press, Ltd 4d net). The main aspects of the problems involved in town and country planning are simply but adequately explained and in a way which should conduce to discussion. There is a short but adequate bibliography, and the pamphlet should fulfil its avowed purpose of bringing home to the ordinary citizen the exact meaning of planning and of how much depends on his contribution and interest if effect is to be given to such proposals as are to be found in the Barlow, Uthwatt and Scott reports.

Much the same can be said of the pamphlet 'The Struggle for Democracy', by W. E. Brown, in the 'Changing Britain' Series (Univ of London Press 1s net). This is even more elementary, and the appeal is largely pictorial. The graphic presentation shows vividly how the development of the British system of government reflects the efforts and strivings of the individuals in the community. The pamphlet indicates not merely how immense has been the broadening of the basis of government and of the sphere of government action in the last century, but also, and more important still, that government is not to be thought of as something apart from the ordinary citizen: it is a matter of 'we', not of 'they', and the interest or inertia of the ordinary citizen, what he does, as well as how he votes, that ultimately shapes our institutions.

Rose-bay Willow-herb and Honey Bees

In the *Bee World* of January, A. Norman Handley discusses the status of the rose-bay willow-herb (*Epilobium angustifolium*). He mentions that the Press has joined forces with the farmers in condemning this plant as a noxious weed. The author believes that it is very questionable whether the plant could establish itself in properly cultivated ground. The roots appear to thrive best on waste lands where the soil is firm and undisturbed. The beekeeper, however, appreciates this herb because it yields valuable nectar and pollen especially during periods of scarcity from about early July until mid-August. In 1944, which was a notoriously bad year for bees, many hives managed to build up and even store surplus nectar from the rose-bay willow-herb. This plant also provides humble bees with food at a time when the next year's queens are being reared. The value of these insects as a general aid in pollination and a particular help in the case of red clover is, of course, well known. Now that the author has brought up this subject it would appear desirable that the true status of this kind of willow-herb should be determined. Much more information is needed before it

will be possible to account for the sudden appearance of the plant in land that has been ploughed or cleared and whether it is due to buried seeds or to other causes

Mme Lepaute : an Eighteenth Century Computer

ELIZABETH CONNOR, Mount Wilson Observatory, Carnegie Institution of Washington, has written (Leaf 189, Astro Soc Pac, Nov 1944) a short account of the astronomical work of Mme Lepaute, whom Lalande considered "the only woman in France who had genuine knowledge of astronomy". As a child she was a voracious reader, and it was generally recognized by those who met her that she had a brilliant mind. When Lalande and Lepaute, to whom Mme Lepaute (*née* Nicole-Reine Étable de la Brière) was married in 1748, collaborated in a treatise on clock-making, Mme Lepaute calculated a table for the book containing a number of oscillations for pendulums of different lengths and the lengths of pendulums corresponding to a given number of vibrations. Her great work was the assistance that she rendered in the computations of the perturbations of Halley's Comet, and Lalande pays her a tribute when he affirms that without her help Clairaut and he would scarcely have undertaken this enormous task. In 1759, Lalande was placed in charge of the *Connaissance des Temps*, and Mme Lepaute became one of his assistants. When this work was given to someone else in 1774, they concentrated their attention on volume 7 of the "Ephémérides", and Mme Lepaute made all the calculations for the sun, moon and planets for both volumes 7 and 8, covering the period 1774-93. In addition to this, she devoted much time to eclipses, computing a table of parallactic angles which was useful in eclipse work. She also made computations for the observation of the transit of Venus in 1761, and wrote a memoir on the subject for the Academy at Béziers. For twenty-five years she was engaged continuously in astronomical work, but her eyesight was finally affected and during the last years of her life she was unable to apply herself closely to the subject.

A 1,000-g Centrifuge

IN CONNEXION with recent development work, the Bell Laboratories have designed a centrifuge for the purpose of subjecting objects to high accelerations under conditions permitting the effects of the acceleration to be studied. The machine is described and illustrated by R. M. Pease in an article in the *Bell Laboratories Record* (22, No 16, Dec 1944). Machines of this general type have been built before, but there was none available that would develop high enough accelerations. For the required tests, an acceleration 1,000 times the earth's gravitational acceleration was needed. To secure this acceleration, two parallel steel rods are clamped at their midpoint and rotated by an adjustable speed D.C. motor. Fastened between the rods at their outer ends is a heavy steel plate to which is secured a mounting for the object under test. With the test object in place, the machine may be driven at the speed necessary to give the desired acceleration. After stopping the machine, the effect on the apparatus under test may be determined. Provisions are also made for observing the effect of the accelerations on the object as the speed of the machine is increased. A neon lamp is mounted to shine directly on the object when the arm is horizontal. At each rotation, this lamp lights for a few millionths of a second from an impulse generated in

a winding on a permanent magnet when a small iron bar attached to the rotating arm passes the pole pieces. For the rest of the time, the arm is in comparative darkness. This stroboscopic arrangement makes the arm appear to stand still in the horizontal position and any distortion of the test object can be observed while the acceleration is being increased.

Electric Lighting Installations for Building Interiors

IN A PAPER on this subject read recently before the Institution of Electrical Engineers, R. O. Ackerley examines the methods which should be adopted in order to answer the various questions which arise when designing an electric lighting installation. The paper stresses the importance of careful task analysis in the first instance to determine exactly what is the visual problem for which suitable lighting must be provided, and goes on to discuss methods of lighting, factors affecting illumination requirements, the selection of appropriate lighting fittings and lamps, and the calculations necessary to determine their location and wattage. The paper also deals with probable trends in lighting in the post-war period and the light sources and materials for light-control that are likely to influence them.

Modern Electric Lift Practice

A PAPER read by L. S. Atkinson before the Institution of Electrical Engineers reviews present-day electric lift practice by making brief reference to those aspects of the subjects which are the concern of the architect, and to the application of lift equipment to suit various classes of building. It explains the changes that have been made in general design from time to time to meet the problems created by the increasing height of buildings and their growing populations, and further describes the equipment as generally installed to-day.

Summer School in Social Biology

A SUMMER SCHOOL in Social Biology and Human Affairs will be held by the British Social Hygiene Council at University College, Nottingham, during July 28-August 11, under the directorship of Prof. Winifred Cullis. This School is designed for teachers and social workers, health visitors, superintendents of children's homes, industrial nurses, etc. Special consideration will be given to educational problems in social biology presented by the coming increase in the school-leaving age. Further information can be obtained from the British Social Hygiene Council, Tavistock House North, Tavistock Square, London, W.C.1.

Announcements

DR W. Q. KENNEDY has been appointed professor of geology in the University of Leeds.

AT a meeting of the Royal Astronomical Society held on April 13, the following officers were elected: *President*, Prof. H. H. Plaskett, *Vice-Presidents*, Dr. E. C. Bullard, Sir Harold Spencer Jones, Prof. E. A. Milne and Mr. F. J. Sellers, *Treasurer*, Mr. J. H. Reynolds, *Secretaries*, Dr. H. R. Hulme and Mr. D. H. Sadler, *Foreign Secretary*, Prof. F. J. M. Stratton, *Members of Council*, Miss M. G. Adam, Dr. H. A. Bruck, Rev. M. Davidson, Dr. M. A. Ellison, Mr. F. J. Hargreaves, Dr. A. Hunter, Dr. E. M. Lindsay, Captain W. N. McClean, Prof. W. H. McCrea, Dr. G. C. McVittie, Mr. P. J. Melotte and Dr. R. Stoneley.

LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications.

Structure of Colchicine

THE suggestion of Dewar¹ that ring *C* of colchicine is 7-membered is interesting, and the arguments which he advances in favour of this merit consideration. I cannot, however, accept his statement that "Cohen, Cook and Roe have now provided evidence that ring *B* must be 7-membered". The paper² to which Dewar refers merely makes a tentative suggestion that ring *B* might be 7-membered. The only legitimate evidence that ring *B* of a degradation product of colchicine (namely, deaminocolchicinol methyl ether) is 7-membered is provided by experiments described in a paper by Barton, Cook and Loudon, recently submitted for publication in the *Journal of the Chemical Society* (and received by the Society on February 1). Consequently, Dewar's assumption in respect of the structure of this part of the colchicine molecule is based on unwarranted speculation. Incidentally, the work of Barton, Cook and Loudon fully establishes the methoxylation pattern of deaminocolchicinol methyl ether, and hence probably also the orientation of the substituents in colchicine.

J W Cook

University of Glasgow Feb 5

¹ Dewar, M J S, *Nature*, 155, 141 (1945)² Cohen, A, Cook, J W, and Roe, E M F, *J Chem Soc*, 194 (1940)

My communication on this subject was written in ignorance of the work of Barton, Cook and Loudon, which was partly disclosed at a meeting of the Chemical Society, but is still unpublished. In relation to the facts known when I wrote, my remarks on the nature of ring *B* in colchicine can scarcely be described as unduly speculative. In any event I reserve any possible discussion for the time when all the facts are available. This question of the structure of ring *B* is, of course, important, but it can be settled by application of routine methods of alkaloid chemistry. On the other hand, the suggestion I have ventured to make regarding ring *C* is quite novel in this field.

Confirmation of the tropolone structure of ring *C* has now been obtained by the degradation suggested by me. Dr I Berenblum very kindly provided a small specimen of colchicine and this was converted to crude hexahydrocolchicine and submitted to lead tetra-acetate oxidation. About 0.6 molecules of lead tetra-acetate were rapidly consumed and considerable further oxidation took place more slowly. This behaviour would be expected in an unsaturated cyclic α -glycol¹. The oxidation product was aldehydic acid gave an amorphous mixture of dinitrophenylhydrazones. Although lack of material prevented purification of the hexahydrocolchicine or isolation of a definite oxidation product, it seems fairly certain that hexahydrocolchicine must indeed be an α -diol. If so, confirmation is provided for the tropolone structure of colchicine.

Previously² resonance chelation was postulated to explain the aromatic nature of the tropolone ring. Calculation shows that in such a structure the O—O distance would be about 2.51 Å and that the O—H bond would be stretched. It is possible, therefore,

that the resonance is an ionic one of the type postulated for colchicine³ and that tropolone forms a tautomeric system of high mobility. On the other hand, the great solubility in water of colchicine, in contrast to colchicine or stipitatic acid, is better explained if in it alone an ionic resonance (implying a semi-zwitterion structure) occurs.

It may be noted that puberulic acid⁴ is probably one of the three possible monohydroxystipitatic acids, and puberulonic acid the corresponding 'tropolone-quinone'. This relationship was pointed out by Birkinshaw, Chambers and Raistrick⁵, and the existing evidence is insufficient for further comment on the structures of those acids.

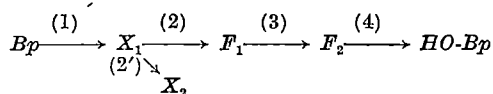
M J S DEWAR

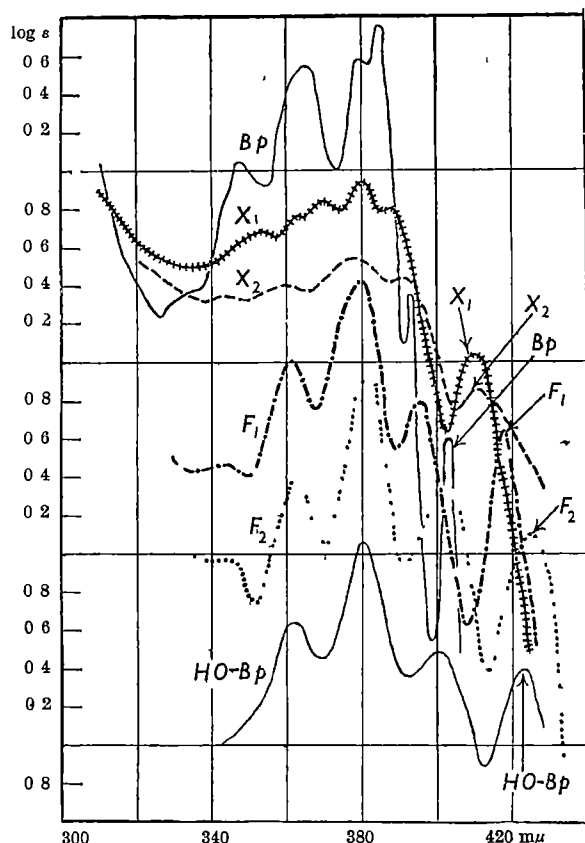
Dyson Perrins Laboratory,
University, Oxford¹ Crigee, *Ber*, 64, 265 (1931)² Dewar, *Nature*, 155, 50 (1945)³ Dewar, *Nature*, 155, 141 (1945)⁴ Birkinshaw and Raistrick, *Biochem J*, 26, 441 (1932) Barger and Dorrer, *ibid*, 28, 11 (1934)⁵ Birkinshaw, Chambers and Raistrick, *Biochem J*, 36, 242 (1942)

Metabolism of 3,4-Benzpyrene in Mice

If 3,4-benzpyrene is introduced into a mouse, it is eventually excreted as the phenol 8-hydroxy-benzpyrene^{1,2}. It has been established that this transformation proceeds by various steps^{3,4}. Four different benzpyrene derivatives have now been separated from extracts of various fresh tissues, they are provisionally termed X_1 , X_2 , F_1 and F_2 , because they are responsible for the 'BPX' and 'BPF' fluorescences that Peacock⁵ and Chalmers⁶ discovered in the liver, bile, intestine and faeces of various animals after application of benzpyrene. The separation of X_1 , X_2 , F_1 and F_2 has been effected by fluorescence chromatography and selective extraction, using alumina and silica as adsorbents and acetone, benzene, xylene, petroleum ether, methyl, ethyl and amyl alcohols and water as solvents. X_1 and X_2 occur *in vivo* not only in the liver and digestive system but also in the lung, kidney cortex, subcutaneous tissue, skin (after painting with benzpyrene), and in the mammary glands as evidenced by the milk of mice. F_1 and F_2 occur in the large intestine and faeces, and occasionally in the lungs. The amount of fresh uncontaminated mouse urine did not suffice for a definite analysis, but there were indications of the presence of the X derivatives. *Post mortem*, all X -bearing tissues show slowly increasing amounts of the F derivatives unless they are kept in formol. The 3,4-benzpyrene-5,8-quinone that Berenblum and Schoental² discovered in the faeces never appeared in fresh tissues.

The sequence of the metabolic conversion can best be seen by following the products through the digestive system. In the liver, X_1 is formed almost exclusively, and enters with the bile into the small intestine, where it is converted slowly to X_2 in the tissue of the wall. However, the bulk of the X_1 is changed to F_1 after its passage through the ileocaecal valve. In the later stages of the metabolism, more and more F_2 appears in the faeces. This sequence can be summarized by the scheme:





ABSORPTION SPECTRA (LOG ϵ) OF 3,4-BENZPYRENE (TOP), 8-HYDROXYBENZPYRENE (BOTTOM) AND FOUR INTERMEDIATE METABOLITES, X_1 , X_2 , F_1 AND F_2 , DISSOLVED IN ARBITRARY CONCENTRATION IN ETHANOL. THE TYPES OF THE GRAPHS ARE SIMILAR FOR Bp , F_1 , F_2 AND 8-HO-Bp BUT DIFFERENT FOR X_1 AND X_2 . THE WAVE LENGTHS OF THE LAST VIOLET BANDS OF THE ABSORPTION SPECTRA (INDICATED BY ARROWS) COINCIDE WITH THE FIRST VIOLET BANDS OF THE FLUORESCENCE SPECTRA OF THE COMPOUNDS (NOT INCLUDED IN THE FIGURE)

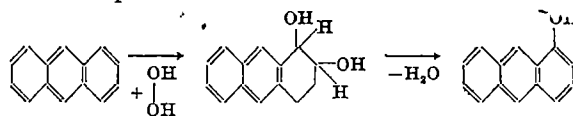
Of these transformations, (2) is the only one as yet that can be effected with the purified substances *in vitro*. It happens when the adsorbate of X_1 on alumina is heated above 150° C *in vacuo*, and slowly when X_1 is kept in dilute hydrochloric acid. This last change, with a simultaneous oxidation to the quinone, proceeds quickly at 100° C.

It has been established that F_1 and F_2 are phenolic, and that F_2 can act as a fluorescence indicator with a change of fluorescence colour from yellow to blue between pH 10 and 9.5. F_1 is strongly adsorbed from benzene and from petroleum ether to alumina with sky-blue fluorescence, F_2 less strongly with yellow-green fluorescence. They are soluble in organic solvents but insoluble in water. X_1 and X_2 are not phenolic, and both are strongly adsorbed from benzene and from petroleum ether to alumina with blue-banded fluorescence spectra, but silica adsorbs only X_2 from amyl alcohol. The X derivatives are soluble in water and in alcohols, but less soluble in benzene and in petroleum ether. The fluorescence spectra of all four derivatives in solution are of a similar type, and show three diffuse bands in the violet-blue distinguished by their position in the spectrum. Their absorption spectra show much more typical differences than their fluorescence spectra. In the accompanying graph, only the absorption spectra in the near ultra-violet and violet are recorded, because the compounds even after

chromatographic purification may contain cell constituents that absorb in the far ultra-violet. The last violet absorption band (marked by an arrow) coincides with the first fluorescence band of the compounds.

None of the derivatives has as yet been analysed owing to their instability and the small amounts that can be recovered from the fresh tissues of mice. However, the absorption spectra especially furnish some evidence of their chemical nature. F_2 has the same absorption spectrum as that published² for 8-OH-benzpyrene (appearing at the bottom of the graph), and it is probably identical with this phenol or a loose conjugate of it. F_1 has the same absorption spectrum except for the violet bands which are displaced by about 7 mμ towards the ultra-violet. This shows its close relationship with F_2 , but the stronger adsorption to alumina (and silica) of F_1 points to a higher molecular weight.

While the type of absorption spectra of the F derivatives is similar to that of benzpyrene itself (top graph) the absorption spectra of the X derivatives are different. Since it is known that the types of absorption spectra of benzpyrene derivatives with intact aromatic 5-ring nucleus are usually similar to each other, the different type of absorption of the X derivatives indicates that this nucleus is *not* intact. Hence the benzpyrene nucleus is altered during the transformation of benzpyrene into the non-phenolic X_1 , and it is restored when X_1 is changed to the phenol F_1 . Boyland and Levi⁷ observed such a phenomenon during the metabolism of anthracene by rats and rabbits. The urine contained the alcohol 1,2-dihydroxy-1,2-dihydro-anthracene with one double-bond less in the anthracene nucleus. This alcohol changes to the phenol 1-anthrol on addition of dilute hydrochloric acid, and the complete aromatic anthracene nucleus is restored. These reactions proceed as follows:



Fieser⁸ suggested the term 'perhydroxylation' for an addition of hydrogen peroxide followed by loss of water, and advanced the hypothesis that such a reaction might be responsible for the metabolic conversion of carcinogenic hydrocarbons to phenols. Hence it is likely that our non-phenolic benzpyrene metabolite X_1 , which changes easily into the phenolic metabolite F_1 is 8,9-dihydroxy-8,9-dihydro-3,4-benzpyrene or one of its conjugates. The stronger adsorption of X_2 on the chromatographic columns points to a higher molecular weight than that of X_1 .

Experiments on the carcinogenic properties of the various metabolites are in progress with Dr J C Mottram, to whom I am indebted for that part of the work concerned with the living animals.

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Feb 5

¹ Chalmers, J G, and Crowfoot, D. *Biochem J*, 35, 1270 (1940)

² Berenblum, I, Crowfoot, D, Holiday, E R, and Schoental, R, *Canc Res*, 3, 151 (1943)

³ Weigert, F, Mottram, J C. *Biochem J*, 37, 497 (1943)

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⁶ Chalmers, J G, *Biochem J*, 32, 271 (1938)

⁷ Boyland, E, Levi, A, *Biochem J*, 29, 2679 (1935) 30, 728 (1936)

⁸ Fieser, L F, *Univ of Pennsylvania Bicentennial Conference* (1940)

Isolation of Asparagine from the Hæmolymph of *Melolontha* Larvæ

DURING a study of the amino-acids of the hæmolymph of insects, a substance was isolated from the blood of *Melolontha vulgaris* which turned out to be asparagine. This finding may be of interest because, to my knowledge, this substance has not been met with in animal fluids or tissues before, while it is a characteristic constituent of many plants.

The blood of some hundred larvæ (15 gm) was leprotenized with trichloroacetic acid, and the filtrate was freed from the acid by extraction with ether. Hexon bases and some peptide or peptides were precipitated with phosphotungstic acid, and carbonic acids were precipitated with barium hydroxide and alcohol. After concentration *in vacuo* and removal of barium with sulphuric acid, mercuric acetate and sodium hydroxide were added by drops until no further precipitate would form.

The precipitate was suspended in water, decomposed with hydrogen sulphide and after removal of mercuric sulphide the solution was concentrated on a steam bath. First tyrosine crystallized out and was removed, and the mother liquor was concentrated further. Irregular crystals of another substance now separated out. They were freed from the glassy mother liquor by digestion with warm 50 per cent alcohol in which the crystals were but little soluble. The substance was repeatedly recrystallized and the resulting sample of an apparently pure substance (10 mgm) was analysed after drying at 110° C. The results are presented below with the theoretical values for asparagine.

	Found (%)	Theory (%)
Total nitrogen	20.7	21.2
mino nitrogen (per mol titre)	11.0	10.6
mino nitrogen (4 hr hydrolysis with 1N hydrochloric acid)	9.2	10.6

The crystals resembled in every respect those of asparagine.

The concentration of asparagine in the blood of the larvæ can only be roughly estimated, due to the inevitable losses on recrystallization. 150–250 mgm per cent should be a probable guess. Blood from larvæ of the related *Oryctes nasicornis* was found to contain 23.7 mgm per cent amide nitrogen, corresponding to 223 mgm. per cent asparagine, but the material did not suffice for an isolation. So it still remains to be seen if asparagine is a peculiarity in *Melolontha* or a typical product of insect metabolism.

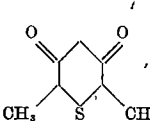
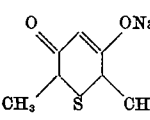
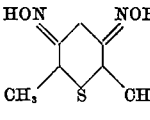
HANS H. USSING

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University of Copenhagen

Antibacterial Activity of 2:6-Dimethyl-Penthiene-3·5-Dione

In a recent speculation Gulland and Farrar¹ have elaborated a hypothesis for the mode of action of *cyclotelluro-pentane-3·5-dione* and homologues, in which substrate competition with pyridoxin is postulated as a possible explanation of their high bactericidal activity. The structural resemblance of these tellurium compounds to that of pyridoxin is pointed out, and it is suggested that analogous substances containing an oxygen or a sulphur atom instead of tellurium might possess correspondingly high bacteriostatic or bactericidal activity without the extreme toxicity of the tellurium compounds.

As we were interested in heterocyclic ring compounds containing sulphur², we have prepared and tested the sulphur analogue of 2:6-dimethyl-cyclotelluro-pentane-3·5-dione, which is the most active representative of the tellurium series of homologues. 2:6-Dimethyl-penthiene-3·5-dione is a white crystalline substance of m.p. 124–125° C, soluble in hot water. It dissolves easily in cold caustic soda solution, but does not give a coloration with alcoholic ferric chloride except on prolonged standing, in which it resembles *cyclotelluro-pentane-3·5-dione*³. It forms a white crystalline dioxime of m.p. 181–183° C, slightly soluble in hot water. The accompanying table shows the results of the bacteriological examination and gives the minimum concentrations inhibiting the growth of one loopful of inoculum.

	<i>Staph aureus</i> NCTC 4163 glucose broth (18 hr at 37°)	<i>Bact coli</i> NCTC 86 Lemo broth (18 hr at 37°)	<i>Bact coli</i> NCTC 86 Reader's medium (24 hr at 37°)
	1 1,600 (1 600,000– 1 10,000,000)*	< 1 1,000 (1 9,000,000– 1 10,000,000)	1 6,400
	< 1 1,000	< 1 1,000	1 3,200
	1 1,000– 1 2,000	< 1 1,000	1 6,400

* The figures given in brackets are the bactericidal concentrations of the analogous tellurium compound reported by Morgan *et al*.⁴

Contrary to expectations, the compounds show little or no activity against the organisms tested. It is interesting to note that enolization, which is a prerequisite in Gulland and Farrar's speculation, in our case decreases or abolishes bacteriostatic activity altogether. The dioxime of 2:6-dimethyl-penthiene-3·5-dione, however, in contrast to the corresponding tellurium compound, is as active as the parent substance. It would appear, therefore, that other factors, apart from the arrangement $-\text{C}(\text{CH}_3)\text{C}(\text{OH})\text{C}-$, as suggested by Gulland and Farrar (*loc cit*) are fundamentally concerned in determining the bacteriological properties of this class of compounds. Our results certainly do not favour their speculation of substrate competition with pyridoxin.

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Feb 26

¹ Gulland and Farrar, *Nature*, 154, 88 (1944)

² Avison *et al*, *Nature*, 154, 549 (1944)

³ Morgan *et al*, *J. Chem. Soc.*, 117, 1464 (1929)

⁴ Morgan *et al*, *Biochem. J.*, 18, 196 (1924)

Constitution of the Salivary Gland Chromosomes of *Chironomus*

SINCE the discovery of giant salivary gland chromosomes in dipterous larvæ¹, cytophysiologists have regarded them as the most favourable material for studying the chemical composition and fine structure of chromosomes, especially the leptonic relation between nucleic acid and protein. The view that chromosomes are chiefly composed of nucleoprotein is now generally accepted. In salivary gland chromosomes, the bands represent regions of relatively high nucleic acid content, while the interbands carry very little, if any, nucleic acid. The results obtained by Feulgen staining², histochemical tests³ and ultraviolet microscopy⁴ have all substantiated this conclusion. Digestion experiments by Caspersson and by Mazia and Jaeger⁵ clearly indicate that the salivary gland chromosomes possess a continuous protein framework the integrity of which is independent of the presence of nucleic acid molecules. In a more definite way, Astbury and Bell⁶ and Schmidt⁷ concluded from their X-ray diffraction and birefringence data that the most important elements in the molecular organization of the chromosomes are the partially folded and partially extended polypeptide chains, together with the parallel fitting of thymonucleic acid on to the extended portion of the chains. Based on this structural principle, Pfeiffer⁸ and especially Calvin and Kodani⁹ have proposed a probable structure for the salivary gland chromosome.

More recently, Stedman and Stedman¹⁰ announced the isolation of an acid protein which was named 'chromosomin'. They considered this to be the chief protein constituent of the chromosome, since its staining behaviour was the same as that of the chromosome. These authors also suggested that nucleic acid, instead of being attached to the chromosome, is present mostly in the nuclear sap. They questioned the reliability of the Feulgen technique as a means of demonstrating the actual location of thymonucleic acid, and interpreted the results of its application on a basis quite different from the hitherto accepted interpretation, which appeared to be supported by the success of staining plant chromosomes with 'developed nuclear stain'¹¹. These novel ideas at once attracted the attention of cytogeneticists, and an interesting discussion of the problem began¹².

Since the work of the Stedmans was done on vertebrate tissues, and since they made no comment on the structure of salivary gland chromosomes, which are large enough to permit of separation from the nuclear sap, we have made experiments on such chromosomes in *Chironomus* larvæ. (1) Instead of producing aldehyde groups by the hydrolysis of thymonucleic acid *in situ*, we allowed 5 per cent aqueous formaldehyde solution to react previously with leucobasic fuchsin *in vitro*, thus producing a 'developed nuclear stain'. The dye thus obtained stained the bands without hydrolysis in exactly the same way as in the standard Feulgen reaction. Nor was there any difference with respect to the differentiation between bands and interbands, if we first impregnated the gland cells with formaldehyde and then immersed them in leucobasic fuchsin. (2) When hydrolysis in normal hydrochloric acid at 60° was prolonged beyond 15 minutes, the chromosomes gradually lost their staining capacity toward the Feulgen reagent and eventually became entirely negative after 20–30 minutes hydrolysis. (3) Salivary gland chromosomes in smear preparations were first

excised and then thoroughly washed with insect Ringer to remove as completely as possible the surrounding materials. Such 'naked' chromosomes gave the same Feulgen reaction as when present in the intact nuclei. (4) In the 'naked' chromosome formaldehyde-developed Feulgen reagent produced typical banded structures without acid hydrolysis. Likewise, a pretreatment with formaldehyde followed by leucobasic fuchsin yielded essentially similar results. (5) Prolonged hydrolysis also made such 'naked' chromosomes behave negatively toward the Feulgen reagent.

In order to explain these results, we assume that the *Chironomus* salivary gland chromosome has a structure something like that proposed by Calvin and Kodani. The ability of chromosomes to take up basic dyes is normally due to the formation of salt-like compound of the latter with nucleic acid. The recent investigations of Kelley¹³ on the dyneucleoprotein reaction has offered confirmation, though somewhat indirect, evidence on this point. The results of our experiments (1) and (4) might seem at first sight to be in accordance with the Stedman view that the chromosomes consist only of acid protein, though the existence of banded structure in the chromosomes is difficult to explain. But the two experiments can equally well be interpreted by assuming nucleic acid to be present on the bands, especially if the perpendicular attachment of planar nucleoside molecules to the bands results in a structure of relatively high porosity and consequent in a greater imbibition of formaldehyde or developed fuchsin in these regions. The loss of staining power toward Feulgen reagent after prolonged hydrolysis (our experiments (2) and (5)) may well be due, as Bauer¹⁴ and Hillary¹⁵ have suggested, to the gradual splitting of a bond between the ribose and phosphoric acid within a nucleotide. But it is the result of our experiment (3) which is particularly hard to reconcile with the Stedmans' view. We certainly do not contend that the 'naked' chromosomes as prepared above are completely free from nuclear sap. But it seems certain that the quantity present would not be sufficient to produce the intense chromosome coloration by the standard Feulgen reaction, if nucleic acids were really present in the sap rather than on the chromosomes. Our experiments, at least those with 'naked' salivary gland chromosomes of *Chironomus*, strongly suggest the presence of nucleic acid in the chromosome.

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S PAI

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- ¹⁵ Hillary, B. B., *Bot. Gaz.*, **101**, 276 (1939).

Interaction of Nitrous Oxide and Hydrogen in the Silent Discharge

THE conductivity ι and nature of a discharge reaction have been shown to depend upon $V - V_m$, where V is the applied potential and V_m its 'threshold' value required to initiate ι .¹ This is illustrated by the varied results for the above reaction, found sensitive to small changes in the operative conditions. The interaction of nitrous oxide with hydrogen, like its decomposition, sets in only above V_m , this increases sensibly linearly with the pressure p , the corresponding total time of reaction rises rapidly with p due to decrease of $V - V_m$.¹

Compared with its thermal analogue² using different catalysts and a wide range of temperature and pressure, changes in the latter and particularly the ratio of nitrous oxide to hydrogen influence markedly the discharge reaction. Its course, with a small pressure (p) and large excess of hydrogen, is simplest p and $1/\iota$ eventually reach a minimum, and remain constant under continued discharge. The final products and p follow the equation $N_2O + H_2 = N_2 + H_2O$, this applies also to the thermal change.² As p is increased, p and $1/\iota$ decrease first slowly and later sensibly faster, these features are accentuated and the initial stage shortens as p and $V - V_m$ are increased. Thus, for example, at 400 mm and 4.3 kV, the initial stage was scarcely noticed, in 8 minutes, p dropped to 300 mm. and ι increased from 0.5 to 4.5 milliamp. At 560 mm and 5.1 kV, however, a sharp deprecitation-like sound was produced immediately the discharge was switched on, the consequent fall in p and $1/\iota$ (which was unsteady) were too large and sudden to follow.

An increase of the proportion of nitrous oxide produces strikingly different results. At low p , after an initial rise, p and ι fall to a constant minimum

As p increases, there is first a large and steep rise in p and ι , then a smaller and slower change in both to a maximum, and finally an overall diminution. A larger p , however, produces a remarkable periodic effect the frequency and duration of which increase rapidly with p and especially the ratio of nitrous oxide to hydrogen. The accompanying figure reveals a close similarity in the time-variation of p , ι and the corresponding energy dissipated in the system, W . As the reaction approaches completion, the successive fluctuations on the p -time curve are 'damped'. At 478 mm, 5.1 kV. and $N_2O/H_2 = 3$, the total time was so long that twenty pressure reversals of practically constant size were observed during about twenty hours. Since ι depends upon $V - V_m$, V_m should vary periodically corresponding to ι , this has been observed.

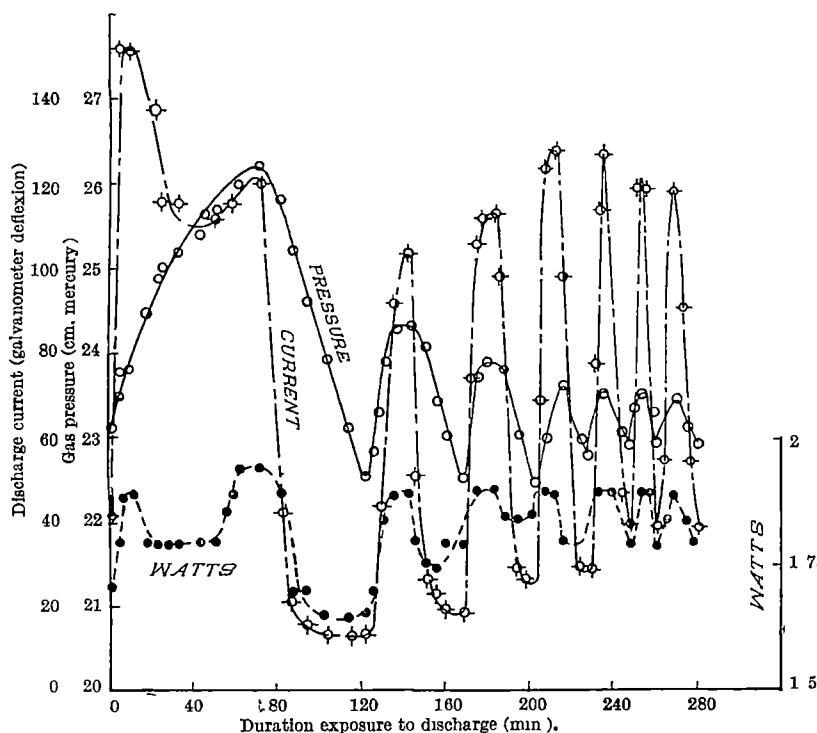
The nature of the glow also changed periodically. As p began to decrease, mobile brushes appeared, their number and intensity increased, and a pink violet glow grew from the annular surfaces, at minimum p it was practically free from brushes. Changes occurred in the reverse order during the ascending part of the cycle. The former spectral sequence was also observed during pressure diminutions with a large excess of hydrogen when the reaction progressed uniformly.

Nitric oxide, nitrogen and free hydrogen observed after short exposures suggest that the decomposition of nitrous oxide predominates in the initial stage,¹ this corresponds to the initial sharp rise in p and ι .

The subsequent slower rise in p and decrease of ι are attributed to the formation of nitrogen trioxide (N_2O_3) and nitrogen dioxide (NO_2).¹ Marked traces of ozone (ozone was also observed in the decomposition of nitrous oxide by silent discharge 1b) together with free hydrogen were detected corresponding to about the first maximum on the p -time curve,

oxygen and water were also observed. Likely interactions leading to products such as nitrogen pentoxide and nitric acid show the extreme complexity of the change.

In the so-called rhythmic and pulsating reactions the velocity, and not necessarily the direction of the change, varies periodically.³ The pressure and the associated synchronous changes especially during the later stages of the present reaction, however, indicate that the corresponding *direction* is reversed periodically. The entire group of these fluctuations was suppressed when the ozonizer was cooled to 7° C, and revived on restoring the temperature. An alternate film-like condensation and evaporation (or/and desorption) is, however, insufficient as a general explanation.⁴ Moreover, attempts to observe such a periodic effect in vapours of water, bromine and iodine under similar conditions of discharge have failed.⁴ That the periodic effect does not necessarily accompany at any rate a partial reversal of reaction was observed in the interaction under



INTERACTION OF NITRIC OXIDE AND HYDROGEN IN THE SILENT DISCHARGE. INITIAL PRESSURE, 23.2 CM. MERCURY, APPLIED POTENTIAL, 2.7 KV (50~), $N_2O/H_2 = 0.61$

discharge of sulphur and nitrogen⁴. During subsequent work on the behaviour of the above products of the nitrous oxide-hydrogen interaction, reversal of change and also a full periodic effect as in the accompanying figure are observed under certain conditions of the decomposition of nitrogen dioxide by the silent discharge⁴.

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- ¹ Joshi, *Trans Faraday Soc.*, (a), 25, 139 (1929), (b) 25, 129 (1927), *Curr Sci.*, 8, 548 (1939), 13, 153 (1944), *Nature*, 154, 147 (1944).
² Hinshelwood, *Proc Roy Soc. A*, 106, 292 (1924). Hutchison and Hinshelwood, *J Chem Soc.*, 129, 1556 (1926). Melville, *Proc Roy Soc. A*, 142, 524 (1933). Dixon, *J Amer Chem Soc.*, 57, 818 (1935). Cassel and Gluckauf, *Z phys Chem.*, B, 19, 47 (1932).
³ Hedges and Myers, "Physico-Chemical Periodicity" (London, 1926).
⁴ Joshi, Pres. Address, Chem Sec., Indian Sci Cong (1943).

Compounds of the Structural Type of Calcium Titanate

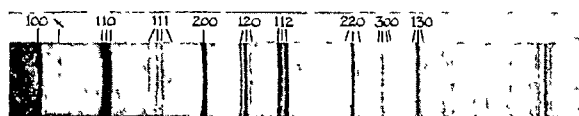
In a previous communication¹, it was recorded that precision X-ray powder methods with a large-diameter camera show that the structure of nickel oxide is not strictly cubic, but only pseudo-cubic. Splitting of some of the X-ray reflexions into more than one component is explained if a small distortion of the cubic lattice along an octahedral axis is assumed, so that the true symmetry is rhombohedral hexagonal.

In the course of investigations on compounds of the structural type of perovskite, CaTiO_3 , it has been found that precision powder methods are capable of demonstrating that only a minority of these crystals have cubic symmetry. Naray-Szabo^{2,3} has recently examined many crystals of the calcium titanate type by means of oscillation diagrams, and has shown that several, including perovskite itself, are monoclinic, and others, for example, lead titanate, are tetragonal or orthorhombic. Using the powdered crystal technique, the differentiations described by Naray-Szabo have been, in general, confirmed, although a small distortion from cubic symmetry has been observed for barium titanate, which is still classed as cubic by Naray-Szabo.

The X-ray powder photographs may be grouped into three main types. For compounds typified by strontium titanate the lines fall in the sequence demanded by the ideal cubic structure. No extra reflexions occur and no splitting of the main reflexions can be distinguished. The ideal cubic structure is therefore valid to a high degree of accuracy.

For some other compounds, of which barium titanate is an example, many of the powder lines are split into more than one component, and the new features can be explained if the symmetry is assumed to be tetragonal. The measured lattice constants of barium titanate are then $a_0 = 3.9866 \text{ kX}$, $c_0 = 4.0195 \text{ kX}$ at 22°C . For lead titanate a still greater distortion of the structure is revealed, the axial ratio being much further removed from unity.

With a larger group of compounds the main powder lines show many complexities and a number of extra reflexions appear in intermediate positions. Part of a powder photograph of calcium stannate is reproduced herewith to indicate the kind of effect which is observed. The main groups of lines have been indexed according to the old cubic structure. One noteworthy



PART OF X-RAY POWDER PHOTOGRAPH (COPPER $K\alpha$ RADIATION, 19 CM CAMERA) OF CALCIUM STANNATE (CaSnO_3).

and characteristic feature of the X-ray pattern of crystals of this type is that a low-order line (x) appears the spacing of which is $2/\sqrt{5}$ that of 100. This indicates that the indices of the main lines should in fact be doubled, and therefore, when an approximation to cubic symmetry is assumed, the unit cell dimensions must be twice those of the ideal perovskite unit cell. For example, the side of the pseudo-cubic unit cell of calcium stannate is approximately 7.87 kX , and not 3.935 kX , the lattice constant for the old structure.

It will be seen that all the members of this large class of compounds, having the general formula ABO_3 , cannot be regarded as isomorphous in the strict sense of the term. Although the ideal lattice has cubic symmetry, in the majority of cases, the cubic structure is appreciably distorted and the true symmetry may be tetragonal or more often monoclinic. There are, no doubt, other groups of compounds, the members of which have similar structural relationships, which would not be embraced by the term isomorphism as at present understood. Naray-Szabo³ suggests that such related structures should be described as 'sister' structures. An alternative would be to use the term 'pseudo-isomorphous' to denote the close structural similarities. This would have the advantage that it follows the accepted custom of using the prefix 'pseudo' to denote structures that are distorted but closely related to the more symmetric crystal systems.

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¹ Rooksby, H P, *Nature*, 152, 304 (1943).

² Naray-Szabo, I, *Naturwiss.*, 31, 202 (1943).

³ Naray-Szabo, I, *Naturwiss.*, 31, 466 (1943).

Crystal Structure of Barium Titanate

It is well known that barium titanate belongs to the group of compounds having structures of the perovskite type¹. The ideal perovskite structure ($G5$ in the "Strukturbericht") has a simple cubic lattice, with one formula-weight per cell, the atomic parameters being as follows: 2-valent cation, $(0,0,0)$, 4-valent cation, $(\frac{1}{2}, \frac{1}{2}, \frac{1}{2})$, oxygens, $(0, \frac{1}{2}, \frac{1}{2})$, $(\frac{1}{2}, 0, \frac{1}{2})$, $(\frac{1}{2}, \frac{1}{2}, 0)$. It was early recognized² that for many of these compounds, including perovskite (CaTiO_3) itself as well as barium titanate, the structure was not truly cubic but was actually a slightly deformed modification of it. Perovskite itself is generally believed monoclinic, the structure has recently been determined in detail by Naray-Szabo³, who finds a monoclinic unit cell with all its edges doubled relative to the unit cell of the ideal structure. No detailed work on barium titanate has hitherto been published, and it was thought of interest to investigate it. Powder photographs of the synthetic material taken in a 19 cm diameter camera with copper $K\alpha$ radiation provided the data for determining the structure.

The structure is tetragonal, the dimensions of the unit cell at 20°C , for a typical sample of material,

being as follows: $a = 3.9860 \pm 0.0005$ kX., $c = 4.0263 \pm 0.0005$ kX., $c/a = 1.0101 \pm 0.0002$. This cell contains one formula-weight, BaTiO_3 . The atomic parameters are the same as in the ideal cubic structure. The relationship between the tetragonal and cubic structure is close; the tetragonal unit cell may be simply derived from the cubic by stretching it homogeneously by about 1 per cent along one tetrad axis, which becomes the c axis.

This close relationship suggests that a transition to the cubic structure may occur at higher temperatures. This was verified from photographs taken with a high-temperature camera. At 200°C ., barium titanate has the ideal cubic structure, with $a_0 = 4.0040 \pm 0.0005$ kX.

Further work is in progress.

I wish to express my gratitude to Sir Lawrence Bragg for allowing me the use of the high-temperature camera in his laboratory. I wish also to thank Mr. J. A. M. van Moll (head of the Material Research Laboratory) and the directors of Philips Lamps, Ltd., for permission to publish this work.

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* Goldschmidt, V. M., "Geochem. Verteilungsgesetze d. Elem.", 8, 153 (1927).

* *ibid.*, and also 7, 37 (1926).

* Naray-Szabo, I., *Naturwiss.*, 31, 202 (1943).

Abrasion of Porcelain Balls

In *Nature* of August 5, 1944 (p. 169), Lord Rayleigh gives a very interesting description of the production of pebbles of regular shape by laboratory abrasion tests. His main conclusion seems to be that pieces of marble of apparently homogeneous texture tend to become oblate or prolate spheroids even though they start from shapes that are roughly cubic or spherical.

We have recently observed a phenomenon that seems far more mystifying, namely, the tendency of porcelain balls when used for grinding refractory materials in a ball mill to assume a roughly cubic

shape. The samples shown in the reproduction at approximately actual size were originally essentially spherical and assumed this dice-like shape after a few months of service. Their original size was approximately twice that shown. The manufacturers of these balls state that they are made by extruding a cylindrical column of batch, cutting this off into lengths, and rolling to give sphericity. Had the extruded section been square an obvious explanation would have suggested itself.

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Nomenclature of Animal Behaviour

Dr. J. S. Kennedy and Dr. D. L. Gunn¹ have discussed the difficulties inherent in the creation of new technical terms in connexion with animal behaviour. Recently Donisthorpe and I have listed (in a paper now in the press²) the specialized scientific terms used in describing and classifying the behaviour of ants. So far as possible, terms used generally in entomology and other branches of biology have been omitted, except where they have a special myrmecological meaning. One hundred and seventy terms have been listed, and each one has been defined, the original author of the term being cited.

In many cases the original definition of a term is inadequate, or common usage may slightly change its meaning, and in such cases a new and, we hope, adequate definition has been given. Numerous synonyms occur, and in such cases both terms have been defined and included in the list. No attempt has been made to 'sink' one term or another.

I hope that when myrmecologists throughout the world have considered this list with its definitions and synonyms, and have pointed out any omissions, then it will be possible to decide by common consent to use certain terms and not others, and to set up a standard myrmecological terminology. It is to be hoped that this process may be continued throughout the biological sciences; but, to my mind, the first and essential step in the process is the listing and defining of the already existing terms.

I agree with Dr. Gunn that the use of common words as technical terms should be avoided. A flagrant case of this exists in myrmecology in the restriction of the terms 'mixed nests' and 'compound nests'. Wheeler³ defined 'mixed nests' as colonies of ants which are composed of more than one species, and in which the brood is not kept separate; and 'compound nests' as colonies of ants which are composed of more than one species, and in which the broods are kept separate. This is most confusing to the non-specialized biologist, and destroys both the natural collective terms for colonies of ants which are composed of more than one species. To get over this difficulty I have recently proposed⁴ the term 'mixtobiosis' to include all cases of mixed and compound nests of ants.

B. D. WRAGGE MORLEY.

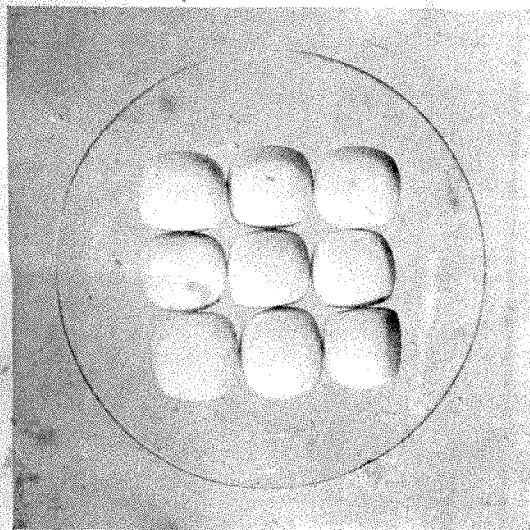
School of Agriculture,
University, Cambridge.

¹ *Nature*, 155, 178 (1945).

² *Roy. Ent. Soc. Lond.*, in the press.

³ "Ants", 423 (New York, 1910).

⁴ *Roy. Ent. Soc.*, in the press.



THE BRITISH EMPIRE CANCER CAMPAIGN

ANNUAL REPORT

IN the introduction to the twenty-first annual report of the British Empire Cancer Campaign, the honorary secretary, Mr. J. P. Lockhart-Mummery, says that "it is a matter of satisfaction that, at the end of five years of war, cancer is being studied in this country with even greater intensity than before". It is indeed remarkable that so much progress should be made. Soon the work should be accelerated.

When proposing the adoption of the report, Prof. F. L. Hopwood directed attention to the possibility of introducing radioactive elements in non-toxic compounds into the body. In this way local concentrations of radioactive material in particular organs or tissues might be achieved. Such a new technique would require expensive equipment for the preparation of radioactive elements, and the work would not be without risks for the operators; but interesting results should be obtained.

Therapy. The treatment of cancer of the prostate with oestrogens has been developed during the past year. The present report gives further evidence of the effectiveness of this treatment. The benefits of therapy have been maintained for long periods in many cases. Cancer of other organs has also been treated with oestrogens. Thirty-six cases of late cancer of the breast have been treated with trichloroethylene or stilboestrol at the Royal Cancer Hospital and the Christie Hospital, Manchester. Of these cases, fifteen showed temporary retardation of the growth, although the effects were in general less than could be expected from local palliative X-irradiation. Of twenty-nine cases of advanced cancer of organs other than prostate and breast, only one (a case of carcinoma of the bladder) showed undoubted partial retrogression. Triphenylmethylethylene was less effective than either stilboestrol or triphenylchloroethylene.

Experiments on chemotherapy of cancer carried out by Dr. A. Haddow and Prof. G. A. R. Kon have been concerned with the action of symmetrical diphenylethylene derivatives. Two of these compounds are especially active in checking tumour-growth in animals.

Carcinogenesis. Studies in carcinogenic action during the past year appear to have been concerned with the elucidation of the action of known carcinogenic agents rather than with the search for new compounds. Carcinogenic agents inhibit body-growth, but this inhibition is most unlikely to be solely due to deprivation of cystine, as had been suggested by American workers.

2-Acetylaminofluorene has been further investigated by Prof. H. N. Green and Dr. F. Bielschowsky. This substance induces liver tumours and a few mammary tumours in rats. Liver damage is probably the primary change, and as a result oestrogens in the body are not metabolized and so may cause an increase in the number of mammary tumours. 2-Acetylaminofluorene does not normally induce tumours of endocrine glands, but in an experiment in which rats were treated with the carcinogen and allylthiourea to stimulate the thyroid, adenomata of the thyroid were induced. Allylthiourea itself induces hyperplasia of the thyroid but is not carcinogenic. Thus acetylaminofluorene is able to induce tumours

in hyperplastic thyroid tissue but not in the normal gland. No liver tumours have apparently been induced in mice treated with acetylaminofluorene in the Sheffield laboratories. Aminofluorene has pronounced bacteriostatic action *in vitro* and this action is inhibited by blood and tissue extracts. Mouse liver gives a much more potent antagonizing extract than does rat liver. 2-Acetylaminofluorene has been isolated from the urine of rats as a metabolite product of the carcinogen.

There is considerable variation in the response by different species or even by different strains to carcinogenic agents. Thus, although coal tar will produce tumours on the skin of mice and rabbits, many hydrocarbons that induce skin tumours in mice will not do so in rabbits. Dr. I. Berenblum has now found that the potent carcinogen, 9:10-dimethyl-1:2-benzanthracene, will produce skin carcinomas on the ears of rabbits. Experiments are proposed to determine if this compound will also induce skin tumours in rats and guinea pigs, which are resistant to most carcinogenic agents.

Dr. A. Glücksmann suggests that the sensitivity of mouse skin varies with the density of the hair coat. The hair follicles act as germinative centres, and the onset of ulceration and papilloma formation coincide with certain phases of the normal hair cycle.

Examination of lubricating oils for carcinogenic activity had made it possible for the Manchester Committee on Cancer to recommend oils which would be expected to be non-injurious from an examination of physical properties. Owing to war conditions, however, the safer oils were not available for some time and there was an increased amount of illness and even death due to epitheliomata of the skin of mule spinners and other workers in cotton mills.

Oestrogenic substances. The possible carcinogenic effects of a number of oestrogenic stilbene derivatives on the skin of mice have been investigated at the Middlesex Hospital. Of thirteen substances tested only one, α -ethyl- β -sec-butylstilbene, induced skin tumours. This compound is but feebly carcinogenic to skin, as only two tumours occurred in twenty-one mice that survived a year of treatment. Attempts to find water-soluble oestrogens have led to the synthesis of sodium hexoestrol phosphate and stilboestrol potassium sulphate. The biological action of aqueous solutions of both these products is being explored both *in vivo* and *in vitro*.

Tumours in pure-line mice. The occurrence of spontaneous cancer in pure-bred strains of mice may be related to other characters of the mice. Thus Dr. F. L. Warren has confirmed the American findings of lowered haemoglobin in the blood of female mice of strains liable to mammary cancer. The strain of CBA mice kept at the Royal Cancer Hospital has a low incidence of mammary cancer, and the mice appear to live longer than mice of strains in which mammary cancer is common. The ovaries and adrenals of mice of this strain have distinct histological differences from corresponding organs of other strains, in which mammary cancer is often seen. The mean concentration of ascorbic acid in the livers of mice of strains with a low incidence of mammary cancer is often lower than the concentration in the livers of mice from high cancer strains.

Dr. G. Bonser, of Leeds, has induced testicular tumours in mice of a number of strains by treatment with oestrogens. The milk factor, or mammary tumour inciter, appears not to influence the incidence of these tumours, but no testicular tumours were

obtained in the CBA strain (a low mammary cancer strain) while all the treated mice of the Strong A strain developed tumours. Other strains gave intermediate responses: the 'white label' and *IFS* strains gave a few tumours, and the *RIII* strain a moderate number of testicular tumours if the mice lived long enough.

The British Empire Cancer Campaign has been concerned with research for twenty-one years and is now taking on the additional duty of advising medical practitioners as to the value of any new form of treatment about which the Campaign has knowledge.

E. BOYLAND

GENETICAL ASPECTS OF THE CANCER PROBLEM

A "PRELIMINARY Report on a Survey of the Situation in Cancer", by Dr Fritz Blank, appears in the *Archives of Surgery, Chicago* (49, No 5, 301, 1944). The general interest of the study warrants a digest showing the limits of the field surveyed and the findings. In his foreword, Prof F. A. E. Crew points out that this survey of the biological background in cancer is the first major attempt by the Bureau of Human Heredity (115 Gower Street, London, W.C.1) to present the results which can be achieved through the 'clearing-house method'. It has been made possible by international collaboration between the Institute and the Department of Medical Genetics of Ohio State University, both of which are foci of much friendly co-operation between individual workers and numerous institutes.

The Bureau of Human Heredity has been developing the mechanism for such work as this since it opened in 1936. The method by which the cross-reference index is made is best compared to a great sorting machine. The desiderata were outlined early on by Profs R. A. Fisher and J. B. S. Haldane in consultation. It works well, three thousand sections on constitution and traits were already available when Dr Blank began the cancer collection, points in the present survey can be set against a further 1,500 or so. This preliminary survey covers most of the literature between 1900 and 1941, with data from about four thousand papers.

The summarized genetical findings are not the less important for presenting no surprises. The myth of hereditary cancer is disposed of. Geneticists are more and more aware in other fields of the fact that hereditary make-up controls type of constitution, in other words, individual variations in physiological function. There is evidence from many sources that carcinogenic agents react differently on various types of constitution. This would be expected from physiological genetics. An illuminating point may be gleaned here, namely, that certain types respond quickly to diverse kinds of irradiation. In another series it appears to be mainly hormone imbalance which prepares the body for growths and/or malignancy. Fortunately, data give at least a rough guide as to means of differentiating between these two major sources of the disease.

It is significant to learn that certain diseases of hereditary type appear frequently as precursors of neoplastic growth and malignancy. Here the clearing-house method may have special importance. Practi-

tioners, by contributing their observations to the Centre, will do much to accelerate accumulation of knowledge of practical value to their colleagues and to humanity.

Dr Blank's survey is set out in chapters dealing with those aspects in which research was sufficiently advanced in 1940 to show a bearing on the biological background, no reference is therefore made to the data on nuclear division, including polyploidy and extrachromosomal factors, on which researches are now in progress. Statistics come first of high genetical interest are comparative figures for different parts of the world and different races. These show that for all those areas and peoples for which reliable figures are available, the general incidence of cancer is practically the same, although site and type of the disease vary greatly, and there is a hint in the Dutch East Indies that hereditary racial characteristics underlie this fact where Malays and Chinese working side by side demonstrate racial incidence comparable to that of their home areas.

Detailed studies in Norway (Waaler, 1931), later repeated by Wassink in Holland, throw light on the question in general and show the complexity of the problem. Greenwood's analysis is as follows: (1) "some forms of cancer (e.g. lip cancer) are produced quite independently of any inheritable *anlagen*, extrinsic factors have greater, perhaps exclusive, influence upon males, (2) the heritable factors show two independent factors, both of which occur with a frequency of about 16%." These, according to Wassink, are the existence of a general predisposition and also a tendency to certain localization.

'Cancer families' are reviewed, beginning with studies in 1856, it has been shown that simple statistical study here is unreliable (Cramer, 1937), since in large families where sibs survive to thirty-five years, the expectation will be approximately that of the general population. Twin studies are mentioned, but since none conforms to the criteria set up by von Verschuer and Kober, the findings are omitted from the general argument.

The work on rodents receives notice proportionate to its importance and covers spontaneous tumours and the reaction of different strains to transplantation and induced tumours. In each series sharp differences in incidence and reaction are noted between stocks within any given species or variety: there are immune, partially immune or tumour-prone. There remains an unresolved problem here in a change of average incidence in experiments with foster suckling (the so-called milk factor). But here also a variation in resistance of the stocks persists, recent work on agglutinogens in milk were not available at the date to which the survey is carried.

Carcinogenic agents are surveyed in detail, the organic type, the viruses, have been the focus of the search for a possible causative factor or prime agent. Occupational cancers stimulated research on chemical agents, and these are reviewed. Work with hormones proceeding over the same period is not unrelated to those investigations, of these, oestrin has given important results, namely, the production of mammary cancer in 100 per cent of male mice in a cancer-prone stock. Cramer and Horning relate this to a heritable faulty metabolism shown as 'brown degeneration of the adrenals'.

Of great practical interest are the data on those diseases with genetic background which are frequent precursors of cancer. These are spoken of as the internal carcinogenic environment. In addition to

neuro-fibromatosis and xeroderma pigmentosum, achlorhydria is typical. The racial data demonstrate a constitutional susceptibility to physical irritants, particularly radiation. The work of Roffo and Findlay calls for further research in this direction although the general facts are clear.

Dr Blank concludes that the complexity of factors noted above will be found to prevail equally in most forms and types and sites of tumours. As the cases of cancer in which we can trace direct hereditary transmission are rare, admittedly they cannot provide a valid answer to the question of whether, or to what extent, an inherited susceptibility plays a part in the general incidence of malignancies. From disorders indicating a purely hereditary proneness to tumour formation, such as xeroderma pigmentosum or neuro-fibromatosis, must be differentiated many other types of tumour formation about which nothing yet is known of an inherited tendency as, for example, cancer of the lip, which according to Waaler seems to be distributed quite independently of any inherited disposition.

Much remains to be done before these problems can be solved, but our task will be lighter if we heed the lesson already taught, namely, that it is vain to ask, "Is cancer hereditary?" and that we must inquire *separately* for each organ, tissue and type of the disease, whether any hereditary factors, *direct* or *indirect*, are involved in a specific form of the malady.

Summarizing our present position meanwhile, we can say that enough evidence has been accumulated to warrant at least the following statements: (a) Cancer is not a unit disease, at least so far as its genetical behaviour is concerned. Tumours of different sites and types differ in their genetical behaviour. (b) Therefore it is unlikely that a heritable condition of 'cancer' exists as such. (c) There does exist a general inherited disposition, whether of susceptibility or refractoriness to tumour formation. (d) In certain individuals factors exist, most probably inherited quite independently of a general disposition, which govern the localization of the disease. This localization in turn seems to depend upon a favourable 'internal environment' in certain tissues or organs. (e) If general susceptibility and inherited favourable internal environment are combined in an individual, these factors may be strong enough in themselves to lead to cancer formation in certain tissues. (f) If general susceptibility is very marked in an individual, even relatively slight irritation by agents of many kinds may lead to cancer formation. (g) But quite apart from these heritable conditions, there exist purely external carcinogenic agents of various kinds, which are obviously strong enough to lead to cancer-formation in certain tissues, even in individuals in whom there is no inherited predisposition, or perhaps it is too weak to be detected by methods used at present in testing for hereditary traits.

The above is a picture of cancer research as seen by the genetically minded physician. The chief aim of the survey has been to show that the whole problem of heredity and cancer is a biological question of highly practical bearing. The writer endorses MacDowell when he says "It is highly regrettable that outside the immediate circle of geneticists, there seems to be an impression that the gene is self-sufficient and is either dominant or recessive. Especially as applied to neoplasms, this misunderstanding has led to erroneous conclusions both on

the part of hostile critics and ardent believer. Dominance is only a special case at the end of continuous series of interrelations between pairs of genes. No gene can produce its effect without the cooperation of many other genes. An genes and extrinsic conditions cooperate in all cases'.

ANTHONY FEILING

POPULATION PROBLEMS IN BRITAIN

SIR W LANGDON-BROWN, addressing the British Social Hygiene Council on the relation of social biology to the population problem (*Brit Med J*, 766, Dec 9, 1944), said that he regarded with grave suspicion the efforts of planners to dethrone the family and hand children over to the State. Some family life is unsatisfactory, but the majority is good. The birth-rate in Britain has fallen steadily since 1870 and, in the same period, the infant death rate had decreased and expectation of life had lengthened. There is evidence that the fertility rate decreases with improved chances of survival. The British Social Hygiene Council has estimated that one-tenth of all marriages in Britain remained childless, but not deliberately so. A study of 2,000 cases suggested that in 60 per cent there was a defect on the man's part. In general, the average male fecundity is much lower than was generally assumed.

Other factors operating against the family are increased rents and rates, which absorb much more than the one tenth of income allowed for these in the Victorian scheme of things. This means that money which should go for food is spent on housing with alarming effects on infant mortality and family life. There is an increase in life in flats due to aggregation of urban populations, and flats are unsuitable for children. A standard rate of family allowances would not be satisfactory. The effects of late marriages and the consequent celibacy forced on our younger people by social changes must be recognized and studied by social biologists.

These and allied problems are the subject of a booklet issued by the Tory Reform Committee entitled "Tomorrow's Children" (P. S. King and Staples, Ltd., 14 Great Smith Street, London, S.W. 1, 1s net). This pamphlet rejects the thesis that the world will get too full in the future, because effort to raise the birth-rate cannot do more than arrest the decline and because the progress of invention and science is always enabling us to support far greater populations at a higher standard of living. The maintenance of these greater populations depends on the fathers and mothers of the next thirty years. The problem before us is whether there will be enough people to keep things going when our grandchildren are grown up. Immigration may affect this problem considerably. Before this War, 50,000 more persons a year were entering Britain than were leaving it. In the future, Britain may attract thousands of the peasant populations of eastern Europe, and we may then be glad to let them in just as the Dominions and the United States were before the War of 1914-18. But at present we are faced with a progressive decline of the population. The apparently satisfactory conditions at present are due, not to a good birth-rate, but to a low death rate, resulting from improvements in public health which allow more old people to survive. The raising

of the net reproduction-rate to 1, instead of the existing rate of 0.75, which this pamphlet recommends as a practical policy, would tend to stabilize the population at about three-quarters of its present figure.

The trend towards a rapid decline of population affects not only Great Britain, but also Norway, Sweden, France, Belgium, Switzerland and Austria, where populations will decline at about the same rate as Britain's will. Other countries, including Ireland, Germany, Italy, Russia, Japan, China and India, will show an increase by 1970.

Among the causes of the population decline the pamphlet discusses (1) the enormously higher standard of living, leisure and comfort, (2) the great increase in mobility, which often makes the home into a place to be left as often as possible, (3) the almost universal literacy and widened outlook, due to reading in the local libraries and daily papers and to the radio, (4) the wide availability of contraceptives, which tend to affect the birth-rate in the groups of higher income and education, and (5) profound changes in our conceptions about religion, duty and social behaviour.

In Britain there is no spiritual significance of parenthood comparable to that which exists in India and China. Education stresses the importance of the individual, so that the child tends to ask what it can get out of life, rather than what it can give.

Among the remedies proposed by the Tory Reform Committee is the creation of a domestic service, which would make housework an attractive career. It also suggests that positive action should be taken in Parliament to bring this whole problem of population and family life more frankly before the people, to remove economic barriers to early marriage and to make two, three or four children an economic possibility in all classes, instead of a severe liability as they are at present. The alternatives against which the young married couples of the next few years can protect us if we enable them to do so are, the Committee thinks, decay through a progressively declining population, or immigration from countries with growing populations, including those of the East.

G. LAPAGE

POLLEN ANALYSIS AND THE MUSEUMS

HA HYDE, of the National Museum of Wales, has published an informative article on the technique, history and applications of pollen analysis (*Museums J.*, Dec 1944).

The study of atmospheric pollens in England began in 1867 when Charles Blackley, a Manchester medical practitioner, exposed to the air micro-slides treated with an adhesive, and found that the days when he slides showed most pollen grains coincided with those on which his hay-fever patients suffered worst.

In 1941 a detailed day-to-day census was begun at Cardiff, and the results obtained during 1942 (see 'Studies in Atmospheric Pollen I. A daily census of pollens at Cardiff, 1942'). By H. A. Hyde and Dr D. A. Williams (*New Phytol.*, 43, 49, 1944) showed that the effective pollen season lasted from early March until late September, and (as previously discovered in the United States) presented three phases characterized by the pollens of trees, grasses and other herbs respectively. The applications of pollen research are numerous. At Cardiff the work is maintained chiefly for the purpose of assisting

medical allergists in making their diagnosis, but in addition because it is of value in the pollen analysis of peat, in experiments on the hybridization of plants, and in meteorological work concerned with the movement of air currents. Again, pollen analysis has been employed—notably in Central Europe—in the determination of the source of origin of honey, and the author suggests that in the future bee-keeping and other departments of horticulture are likely to benefit from similar research. In this connexion he directs attention to the fact that the kinds of pollen collected by certain species of bees are already being investigated under official auspices.

Geological or archaeological correlations are probably the most widely known applications of pollen analysis, but the work so far carried out does not yet provide a complete and independent time-scale for dating archaeological finds. It has, nevertheless, made possible the reconstruction of the forest history of England and Wales since the close of the last Ice Age, and the working out of a number of correlations with human culture periods.

At the end of his paper the author suggests that "(pending the establishment of an institute of palynology)" at least the national museums should carry out fundamental pollen research, and that the larger regional museums might consider undertaking certain aspects of the work. In support of the desirability of this, he points out that certain public authorities in the United States carry out daily analyses of atmospheric pollens, and he is of the opinion that it will not be long before similar observations will be required in Great Britain. Collaboration between museums and public health authorities (both often under the same municipal authority) would, therefore, be of mutual advantage.

FORTHCOMING EVENTS

Saturday, April 21

SOCIETY OF INSTRUMENT TECHNOLOGY (at the London School of Tropical Medicine, Keppel Street, Gower Street, London, W C 1), at 11 a.m.

ASSOCIATION FOR SCIENTIFIC PHOTOGRAPHY (at Caxton Hall, Westminster, London, S W 1), at 2.30 p.m.—Mr E. Mackie "A Consideration of the Requirements for Micrography and Cinemicrography Apparatus"

Monday, April 23

ROYAL SOCIETY OF ARTS (at John Adam Street, Adelphi, London, W C 2), at 1.45 p.m.—Sir Frank Smith, G C B, G B E, F R S "Chemicals from Petroleum" (Cantor Lectures, 2)

ROYAL GEOGRAPHICAL SOCIETY (at Kensington Gore, South Kensington, London, S W 7), at 5 p.m.—"Enthronement of the Dalai Lama, and Journeys in Bhutan" (Kodachrome Films by Sir Basil Gould, with Commentary by Colonel F. M. Bailey)

INSTITUTION OF ELECTRICAL ENGINEERS (at Savoy Place, Victoria Embankment, London, W C 2), at 5.30 p.m.—Discussion of "Electrical Aids to Public Speaking" (to be opened by Mr P. G. A. H. Voigt)

ASSOCIATION OF AUSTRIAN ENGINEERS, CHEMISTS AND SCIENTIFIC WORKERS IN GREAT BRITAIN (PHARMACEUTICAL GROUP) (at the Austrian Centre, 69 Eton Avenue, Hampstead, London, N W 3), at 7.30 p.m.—"Some Interesting Facts on Sex-determining Compounds" (based on work by Mr R. Kuhn)

Tuesday, April 24

SHEFFIELD METALLURGICAL ASSOCIATION (at 198 West Street, Sheffield 1), at 6.30 p.m.—Dr H. O'Neill "The Significance of the Mechanical Test Properties of Metals"

QUEKETT MICROSCOPICAL CLUB (at the Royal Society, Burlington House, Piccadilly, London, W 1), at 7.30 p.m.—Mr A. C. G. Best "Celloidin Embedding and Sectioning"

Wednesday, April 25

SOCIETY OF CHEMICAL INDUSTRY (FOOD GROUP) (at the Chemical Society, Burlington House, Piccadilly, London, W 1), at 2.30 p.m.—Annual General Meeting, Mr A. N. Duckham "Food Management and the Chemist"

SOCIETY OF CHEMICAL INDUSTRY (NEWCASTLE-UPON-TYNE SECTION) (in the King's Hall, King's College, Newcastle-upon-Tyne), at 6 p.m.—Dr M. P. Appleby "The Chemist and the Air" (First Dunn Memorial Lecture)

Thursday, April 26

LINNEAN SOCIETY OF LONDON (joint meeting with the ZOOLOGICAL SOCIETY OF LONDON) (at Burlington House, Piccadilly, London, W 1), at 4.30 p.m.—Sir Frank Colyer "Caries of the Teeth in Animals", Dr Clara M. Warren "Fungus Infections of the Skin", Mr V. V. Tchernavin "Description of Five Specimens of Lyomeri (Deep Sea Fishes) preserved in the British Museum, with Notes on their Skeletons", Mr C. J. A. Berkeley "The Ovale of *Digitalis purpurea* Linn."

INSTITUTION OF ELECTRICAL ENGINEERS (at Savoy Place, Victoria Embankment, London, W C 2), at 5.30 p.m.—Sir Edward Appleton, K C B, F R S "The Scientific Principles of Radiolocation" (Thirty-sixth Kelvin Lecture)

Friday, April 27

ROYAL INSTITUTE OF CHEMISTRY (at the London School of Hygiene and Tropical Medicine, Keppel Street, Gower Street, London, W C 1), at 5 p.m.—Dr J. H. Quastel, F R S "Soil Metabolism"

ROYAL INSTITUTION (at 21, Albemarle Street, London, W 1), at 5 p.m.—Prof F. A. Buxton, F R S "Natural History of Scrub Typhus"

TELEVISION SOCIETY (at the Institution of Electrical Engineers, Savoy Place, Victoria Embankment, London, W C 2), at 6 p.m.—Mr S. Rodda "Beam Tetrodes"

Saturday, April 28

NUTRITION SOCIETY (joint meeting with the BIOCHEMICAL SOCIETY) (at the London School of Hygiene, Keppel Street, Gower Street, London, W C 1), at 11 a.m.—Discussion on "The Vitamin-B Complex"

INSTITUTE OF PHYSICS (ELECTRONICS GROUP) (joint meeting with the MIDLAND BRANCH) (at the University, Edmund Street, Birmingham), at 2.30 p.m.—Dr H. Kuhn "Atomic and Molecular Beams"

Sunday, April 29

ASSOCIATION OF AUSTRIAN ENGINEERS, CHEMISTS AND SCIENTIFIC WORKERS IN GREAT BRITAIN (at the Austrian Centre, 69 Eton Avenue, Hampstead, London, N W 3), at 11.30 a.m.—Dr B. Burzyn "On Recent Applications of Thermo-setting Resins on Paper and Textiles"

APPOINTMENTS VACANT

APPLICATIONS are invited for the following appointments on or before the dates mentioned

ENGINEER by the Government of Iraq to take charge of the Central Technical Section of the Directorate of Municipalities—The Ministry of Labour and National Service, Central (T and S) Register, Room 5/17, Sardinia Street, Kingsway, London, W C 2 (quoting C 2378 A) (April 26)

DEPUTY ELECTRICAL ENGINEER to the Stalybridge, Hyde, Mossley and Dukinfield Transport and Electricity Board—The Ministry of Labour and National Service, Central (T and S) Register, Room 5/17, Sardinia Street, Kingsway, London, W C 2 (quoting D 1170 XA) (April 26)

BOROUGH ELECTRICAL ENGINEER AND PUBLIC LIGHTING SUPERINTENDENT—The Town Clerk, Town Hall, Morley (endorsed 'Borough Electrical Engineer') (April 30)

ASSISTANT MASTER to teach SCIENCE in the Junior Technical School and in part-time Engineering and Building Classes in the Hinckley Technical College (special qualifications in CHEMISTRY would be an advantage)—The Director of Education, County Education Offices, Grey Friars, Leicester (May 3)

MANAGER for an important Division of well-known Precision Engineering Company (good engineering degree or equivalent professional engineering qualification will be regarded as essential, in addition to technical, commercial and production experience)—The Ministry of Labour and National Service, Central (T and S) Register, Room 5/17, Sardinia Street, Kingsway, London, W C 2 (quoting C 2550 XA) (May 5)

ASSISTANT LECTURER in the MECHANICAL ENGINEERING DEPARTMENT—The Principal and Secretary, Harris Institute, Preston (May 7)

SENIOR LECTURER (woman) in APPLIED MATHEMATICS—The Principal, Royal Holloway College, Englefield Green, Surrey (May 8)

SUPERINTENDENT OF TECHNICAL SUBJECTS (candidates must have an Honours Degree in MATHEMATICS and/or SCIENCE) to the Glasgow Education Department—The Director of Education, 129 Bath Street, Glasgow C 2 (May 12)

DEMONSTRATOR (man or woman) in the PHYSIOLOGY DEPARTMENT—The Warden and Secretary, London (Royal Free Hospital) School of Medicine for Women, 8 Hunter Street, London, W C 1 (May 18)

PRINCIPAL of the DARWEN TECHNICAL SCHOOL—The Divisional Education Officer, Education Offices, Darwen, Lancs (May 31)

ENGINEER to the Clyde Navigation Trust—The General Manager and Secretary, Clyde Navigation Trust, 16 Robertson Street, Glasgow, C 2 (endorsed 'Engineer') (May 31)

READER (full-time) in INDUSTRIAL HEALTH—The Secretary of University Court, The University, Glasgow (June 1)

ASSISTANT LECTURER (Grade III) or LECTURER (Grade II) in GEOGRAPHY—The Secretary, The University, Edmund Street, Birmingham 3, (June 2)

TECHNICAL ASSISTANT for Clinical Laboratory work (non-resident, female)—The General Superintendent, Royal Infirmary, Manchester BIOCHEMIST, preferably with some experience of INDUSTRIAL BACTERIOLOGY—The Director of Research, Linen Industry Research Association, Research Institute, Lambeg, Co Antrim, Northern Ireland

TEACHER (full-time) of MATHEMATICS—The Principal, Enfield Technical College, Queensway, Enfield, Middlesex

CHIEF ENGINEER to work in close collaboration with scientific staff in machinery development—The Director, British Cotton Industry Research Association, Shirley Institute, Didsbury, Manchester 20

REPORTS and other PUBLICATIONS

(not included in the monthly Books Supplement)

Great Britain and Ireland

Geological Survey of Great Britain Scotland Wartime Pamphlet No 30 Sands and Gravels of Scotland, Quarter-inch Sheet 12, Stonehaven—Perth—Dundee By Dr J. G. C. Anderson, with contributions by D. Haldane, Pp 32 (London Geological Survey and Museum 1945) 1s 6d

The Estimation of Vitamin A By N. T. Gridgeman Pp 76 (Port Sunlight Lever Bros and Unilever, Ltd, 1945) 6s

Hull Bulletins of Marine Ecology Vol 1, No 6 Continuous Plankton Records—The Zooplankton (other than Copepoda and Young Fish) in the Southern North Sea, 1932-37 By Dr G. T. D. Henderson and N. B. Marshall Pp 255-276+plates 126-139 (Hull University College, 1944) 4s

Ministry of Fuel and Power Committee on the Efficient Use of Fuel Fuel Efficiency Bulletin No 38 The Maintenance of Industrial Boiler Plant (F E C 312) Pp 20 (London Ministry of Fuel and Power, 1945) Free

Electricity for Aircraft By C. G. A. Woodford Pp 28 (London Royal Aeronautical Society, 1945) 6d

College of the Pharmaceutical Society Annual Report for 1944 of the Research Departments Pp 30 (London Pharmaceutical Society, 1945) 8s

Scottish Education Department Technical Education an Interim Report of a Special Committee of the Advisory Council on Education in Scotland (Cmd 6593) Pp 14 (Edinburgh and London H. M. Stationery Office, 1945) 3d net

Manchester Museum University of Manchester Report of the Museum Committee for the Year 1943-44 Pp 24 (Manchester Manchester Museum, 1945) 6d

City of Birmingham Education Committee Scientific Vocational Guidance and its Value to the Choice of Employment Work of a Local Education Authority Report of Research by E. Patricia Hunt and Percival Smith Pp 80 (Birmingham Education Committee, 1944) 2s. 6d

Report of the Television Committee Pp 26 (London H. M. Stationery Office, 1945) 6d net

British Standard Architectural and Building Drawing Office Practice (BS 1192 1944) Pp 32 (London British Standards Institution, 1944) 5s net

Medical Research Council Industrial Health Research Board Report No 86 A Study of Certified Sickness Absence among Women in Industry By Dr S. Wyatt, assisted by R. Marriott, W. M. Dawson, Norah M. Davis, D. E. R. Hughes and F. G. L. Stock Pp 34 (London H. M. Stationery Office, 1945) 9d net

Ollscoil na h-Eireann National University of Ireland Calendar for the Year 1944 Pp x+617 (Dublin National University of Ireland, 1944)

Enterprise an Account of the Activities and Aims of the Tennant Group of Companies First Established in 1797 Pp 168 (London, Charles Tennant and Co, Ltd, 1945)

Other Countries

U.S. Department of Agriculture Technical Bulletin No 877 Wheat Varieties Resistant to the Hessian Fly and their Reactions to Stem and Leaf Rusts By W. B. Cartwright and R. G. Shands Pp 6 (Washington, D. C. Government Printing Office, 1944)

"Jupiter" Theory of the Origin of the Solar System By Percy A. Campbell Pp 10 (San Francisco The Author, 1945)

Carnegie Institution of Washington Publication 562 Scientific Results of Cruise VII of the *Carnegie* during 1928-1929 under Command of Captain J. P. Ault Chemistry—I Chemical Results of the Last Cruise of the *Carnegie* By Herbert W. Graham and Erik G. Moberg Pp vi+58 (Washington, D. C. Carnegie Institution, 1944) 1 dollar

Annual Report of the Board of Regents of the Smithsonian Institution showing the Operations, Expenditures and Condition of the Institution for the Year ended June 30, 1943 (Publication 3741) Pp xi+609+141 plates (Washington, D. C. Government Printing Office, 1944) 2 dollars

Cytogenetic Studies on *Dioecious Melandrium* By Doris Love (Reprint from *Botaniska Notiser*, 1944) Pp 123-214 (Lund C. W. K. Gleerups Forlag, 1944)

On the Aims and Methods of Biological History and Biography with some Notes for the collaborators of the Index Botanicorum By Frans Verdoorn (*Chronica Botanica*, Vol 8, No 4) Pp 425-448 (Waltham, Mass. Chronica Botanica Co., London Wm Dawson and Sons, Ltd, 1944)

Government-Owned Patents and Inventions of Government Employees and Contractors Second Report of the National Patent Planning Commission Pp 27 (Washington, D. C. National Patent Planning Commission, 1944)

Carnegie Institution of Washington Publication 545 Scientific Results of Cruise VII of the *Carnegie* during 1928-1929 under Command of Captain J. P. Ault Oceanography—I A Observations and Results in Physical Oceanography By H. U. Sverdrup, J. A. Fleming, F. M. Soule and C. C. Ennis Pp vii+156 (Washington, D. C. Carnegie Institution, 1944) 1.75 dollars

An Interim Report of the Committee on Medicine and the Changing Order to the Fellows of the New York Academy of Medicine Pp 20 (New York New York Academy of Medicine, 1945)

Proceedings of the California Academy of Sciences, Fourth Series Vol 25, No 15 A Revision of *Phacelia Section Miltizia* By John Thomas Howell (Alice Eastwood Semi-Centennial Publications) Pp 357-376 (San Francisco, Calif. California Academy of Sciences, 1944)

Comissão dos Monumentos e Relíquias Históricas de Moçambique First Impressions of an Archaeological Tour of the Southern Extremity of the Colony of Moçambique By Prof C. van Riet Lowe and Prof Henri Breuil Pp 28 (Johannesburg Prof C. van Riet Lowe, University of the Witwatersrand, 1944)

NATURE

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TECHNICAL RESEARCH IN A REHOUSING PROGRAMME

ON the national plane, the present period of great technical advance involves special difficulties which have been well illustrated in recent debates on the place of temporary and permanent houses in our building plans. It is clear that we must be ready to take full advantage of the many technical advances and of any improved methods of construction, but it is more than doubtful whether we are yet ready to decide which methods are likely to be most suitable for our various purposes. This is necessary not only to ensure efficiency, economy and speed in the development of our building programme, but also to ensure that our plans for raising and training a vast labour force take proper account of possible changes in building technique.

In his book "Re-building Britain—a Twenty Year Plan"*, Sir Ernest Simon sets out to delineate the conditions for outstanding success in a rebuilding programme, and, drawing upon his years of experience in Manchester and as an adviser to the Government, he gives a comprehensive survey of the possibilities and difficulties of rebuilding both houses and communities in Britain after the War. The book falls into two parts, dealing with housing and planning, respectively. The first includes a concise account of the achievements and shortcomings of the housing programme of 1919–39 and at the same time indicates the better preparations which have been made by the Government during the present War to organize the production of houses when hostilities cease. But while Sir Ernest brings together many facts and figures not easily obtainable and his book constitutes a useful reference work both in respect of planning and of building and housing, the treatment is somewhat uneven. It can scarcely be maintained that even within the limits he sets himself—Sir Ernest explicitly excludes the problems of the country, some aspects of the building industry, and the general aspect of the rent problem—he deals adequately with all the factors involved.

This reservation applies to many of the questions in which scientific workers themselves are more particularly interested. He notes, it is true, in his appreciation of the inter-war effort, that there was little or no research on the structure or fittings of the house, but his two chapters on technical planning and on prefabrication lay nothing like the stress on the importance of research which is given by Mr John Madge in "The Rehousing of Britain" in the Target for To-morrow Series†. Mr Madge points out, notably in a section on "The Gaps in our Knowledge", that energetic research is essential if we are to avoid one of the greatest dangers in the immediate post-war period. Without full knowledge of conditions and of new materials and building technique, we may waste time and effort upon second-rate solutions, even if reconstruction does not cut right across any integrated plan.

* Rebuilding Britain—a Twenty Year Plan By Sir Ernest Simon Pp 256+16 plates (London Victor Gollancz, Ltd, 1945) 6s net
† The Rehousing of Britain By John Madge (Target for To-morrow Series) Pp 64 (London Pilot Press, 1945) 4s 6d

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The greatest gaps are in the field surveys of the physical and economic conditions of our towns and regions, as was stressed by Mr E Carter in his paper on "Science and Housing" at the British Association Conference last January. If, in an attempt to alleviate the acute shortage which already exists and which will be accentuated by demobilization and the return of business offices to the towns, new housing and new office block schemes are rushed up in any space available before the new pattern has been determined, the future may be mortgaged to the immediate demand and the emergence of the new plan may be hampered for fifty years or more. This is the reason why it is so important to implement the social survey technique of obtaining housing information described by Dennis Chapman to the Agricultural Science Board in a paper appearing in the *Journal of the Royal Institute of British Architects* last year (51, 191, 1944), and in his paper on "Science and Housing" in the same journal, Mr A M Chitty shows the part which science has to play in developing the designs which will embody the results of such investigations, whether on the material plane, in securing effective economy of labour, of material and of time in the home, and on the social plane in relating the home to the proper working of the community as a whole.

While there is every indication, as both Mr Madge and Sir Ernest Simon recognize, that the Government is alive to the need for extended research in the technical field, it is less apparent that the bearing of such research on the labour situation is fully appreciated. Unless due attention is given to this aspect, however, we may find that after ten years or so we have a surplus of craftsmen trained in the traditional methods, and lack the skilled men we need to exploit modern processes. At present, as Mr Madge points out, the numbers proposed in the Government's plan for the traditional crafts appear to be over-liberal, and the allowance for current and prospective changes in building technique inadequate. Foresight, in fact, is as essential as energy in planning the housing drive, but without adequate research and experiment foresight is impossible. The changes in organization of the Ministry of Works and Building outlined by Mr Duncan Sandys in the House of Commons on March 23 may assist in repairing this defect, but only if the work of the separate department to undertake research and scientific development, of which Sir Reginald Stradling is to be the head, is effectively co-ordinated with the activities both of the Controller-General's department for building materials and building labour, and of the Director-General's department responsible for all building work, including factory production, transport, erection of temporary houses, etc.

So far as research into the properties and application of materials and techniques is concerned, the need for the future is for more research and, as Mr Madge insists, for research subordinated to the interests of the consumer rather than designed to push the products of any one firm or group of firms. Mr Chitty's paper demonstrates the need for more fundamental research, particularly in such fields as

thermal insulation and sound, ventilation and lighting, the prevention of moisture penetration, elimination of fire hazards, and the utilization of new materials so as to secure the requisite strength and stability, and the comparatively neglected problem of durability and maintenance, without attention to which decisions regarding obsolescence and a statutory life of buildings, for which Sir Ernest Simon calls, cannot well be made.

Leaving on one side the further question of service which also requires research and development, if the scientific worker is to design for high standards which can effectively be translated into the service of the needs of the mass of the people, the question of standardization becomes important. Mr Madge suggests that it should be possible for a member of the public to obtain official advice as to the quality of any particular building material or product, and restrictions should prevent any manufacturer from squandering national resources by investing labour and materials in unsatisfactory projects. The adoption of standards based on social and technical research, not merely for equipment but also in matters of space, permanence and amenity, would give a new positive basis to by-laws in place of the present restrictive system, and might go far to end the anarchic rule of jerry-building.

A scientific code of standards would also assist in securing the modification of those by-laws which based on the assumption that only traditional materials are to be used, have seriously retarded the development of legitimate new techniques and materials. Adoption of specification on a basis of performance standards would mean that each material or technique would stand or fall by the vigorous application of scientific tests. The efficiency of traditional building methods and of factory technique would thus be judged solely on their relative fitness for the purpose and would not be subject to irrelevant prejudice. The six-year programme suggested by Mr Madge, within which the temporary factory made house programme would be completed, would provide an opportunity for this testing, and the Building Requisites Board suggested by Sir Ernest Simon, taking over the responsibility for research and development from the Ministry of Works, should make a valuable contribution to this essential definition and adoption of standards where the Ministry might be less effective.

But this question of development leads us into other fields also. We have already seen its bearing on the effective use of the available labour supply by its contribution to personnel management and in securing the integration of management and workers through the works committees and in other ways, but there is a further aspect of even greater importance which is implied rather than discussed in a report on the interrelationship of architecture, engineering and the building and domestic equipment industries which has been prepared by Mr R Chapman and Mr R Perry at the request of the Engineering Industries Association. The sharing of housing among several industries, which is involved in factory production and the introduction of built-in equipment, is

robably the soundest means of dealing with the ultimate problem of contraction of the labour force which Sir Ernest Simon, for example, notably fails to discuss.

This report to the Engineering Industries Association declares that while the 'Portal house' has been evolved hastily to meet a political need without adequate research into the organizing, technical, economic and town-planning problems involved, it has opened the door to complete factory production and new technique. Based on an existing outline proposal, which by adequate research and development could readily and cheaply permit the evolution of a house without the defects of the Portal house, the report visualizes an annual target of 200,000 factory-made houses and 100,000 composite houses, partly additional and partly steel frames. Small research groups are suggested to carry out the initial experimental work, and the need for combining the technical and the economic approach is stressed.

The immediate need, according to this report, is for 2,000,000 building workers, and the long-term need for 800,000, both figures being spread over the additional building trades and the engineering industries. While the advantage of sharing building among several industries is undoubted, the absence of figures in the White Paper and elsewhere showing the relative costs of factory-produced houses built on additional lines in terms of man-hours, for example, makes it difficult to decide which method to adopt for the immediate programme. The debate in the House of Commons on March 22 and 23 established very clearly the crucial importance of the labour supply, and it is doubtful whether even for our short-term programme we can afford to adopt the factory-produced house if it makes bigger demands on manpower than traditional construction. On this point the admirable account of the demonstration houses and those erected at Northolt by the Ministry of Works* gives no more information than the White Paper.

Apart from Mr Horabin, speakers in the debate on housing paid little attention to research. Mr Horabin, however, stressing the fundamental importance of adequate housing research as a basis for the Government's programme—he is prepared to consider an expenditure of £7,000,000 for research—considers we have no adequate research in this field and urged that it is equally important to have the right people in charge of a department of housing research. They should be men of scientific standards, with engineering experience, and, besides technical research, we need statistical and consumer research. Statistical research is required to get an accurate, qualitative picture of the housing situation, and only through statistical and consumer research can we expect to arrive at the number of one-, two- and three-bedroom houses we require. Moreover, this co-ordinated research is required to reduce the number of man-hours on the site and to ensure that as much as possible of such work is done not only by craftsmen but also by selectors and assemblers.

Mr. Horabin recognizes the vital importance of efficient and enlightened management. Sir Ernest

Simon stresses this point also, it is necessary to secure the utmost economy of labour and the whole-hearted co-operation of the workers in the building industries. But it was left for Commander King-Hall to point out that part of the price to be paid for a solution of the housing problem is direction of labour and material, and much better control of land. Mr Madge in his book, like Sir Ernest Simon, recognizes the necessity of maintaining war-time controls over the costs and priorities of the building industry, and both books bring out this essential point that reconstruction must be within the framework of a national development pattern administered by a strong central planning authority. Rarely, however, is the fact faced frankly that labour, too, must accept restrictions, but it is essential, as Mr Buchanan pointed out in the House of Commons, that private and sectional interests should be seen to be subordinated to the interests of the nation as a whole. That is a first step, if we are to secure a much more helpful attitude than has yet been apparent in the building trade unions to the changes that are involved in pre-fabrication and other developments coming from building research.

"Rebuilding Britain", however, is not merely a compendium of facts, as indicated by its sub-title, Sir Ernest Simon sets out a definite plan, and this as well as its critical appraisal of the inter-war achievement and of the Government's weaknesses in dealing with the wider issues give additional interest to the book. In regard to the inter-war achievement, Sir Ernest points out that while it took fifteen years to work up to the building of 350,000 houses per annum in the national housing effort as a whole, an entirely new minimum standard of working-class houses was adopted. A second outstanding achievement, which no other great country has approached, was the building during 1919-39 of no less than four million new houses. These achievements should be remembered, although it is admitted that for financial reasons the houses tended to be too small, there was no adequate control over jerry-building, planning of the housing estates tended to be rigid and unimaginative, and the bigger questions of planning were scarcely considered.

Sir Ernest Simon's own twenty-year plan consists of three stages. The first, aiming at a house for every family, would take about five years, with the provision of 400,000 houses in each year from the fourth after the end of hostilities. In his estimate, however, he only provides for 50,000 in the first, and 100,000 in the second year, as against the 220,000 completed houses and 80,000 in course of erection of the Government's White Paper (Cmd 6609, H.M.S.O., 1945, 2d). The second stage aims at clearing the slums, with four million new houses to be built in ten years for slum clearance and four million cleared houses to be pulled down. This should be completed in sixteen years after the end of the War, and the third stage, involving the clearance and replacement of one million and a half obsolescent houses, should be complete in a further four years.

It may be argued that Sir Ernest deals too summarily with the question of scrapping houses and of

* Demonstration Houses. Pp 76 (London, H.M. Stationery Office, 1944) 1s net.

statutory life which PEP analysed last year in a broadsheet entitled "Old Houses". He does not allow in his estimate for the effect of a declining population upon demand, and he does not discuss at all the difficulty of contracting the labour force either on the completion of his twenty years plan or when the demand falls off under the influence of population changes and the altered obsolescence position. In his summary rejection of the Pole Report on "Private Enterprise Housing", he scarcely attempts to deal with the difficulties of sharing housing between municipal and private enterprise—his leaning to municipal housing makes him underestimate the difficulties, and he seems sometimes to forget that Manchester is scarcely a typical local authority and many local authorities have nothing like Manchester's resources or vision.

What Sir Ernest Simon does do in this book, especially in the last two parts, where he surveys first some foreign examples of planning and then the position in Britain, is to show how lamentably weak the Government's policy is in community planning, and how important the Government's failure to deal effectively with the question of the control of land in the national interest and the problem of compensation and betterment may yet prove to be. This is the second of the five conditions he lays down as essential for successful planning—the other four are suitable planning authorities—national, regional and local—adequate finance, proper national and local plans, and the necessary driving force to see that the job is done. But while he leans to national ownership as the only satisfactory solution of the land problem, he regards this as at present politically impracticable, and the examples he cites show what sound community planning can do without public ownership provided the planning powers are adequate.

Although Sir Ernest does not always answer the questions he raises, he puts the whole problem in a sound perspective and his book should assist in building up that intelligent public opinion which must supply the driving force in the successful rebuilding of Britain. The other two conditions are national prosperity and low rate of interest, and the book shows far more clearly than the White Paper how the housing question is related to the problem of full employment. Sir Ernest is optimistic. He recognizes the enthusiasm of the local authorities and the determination of many city councils to rebuild their cities on fine and imaginative lines. These, and the vigorous steps taken by the Government to ensure a strong building industry and to get to work quickly on housing after the War, are encouraging. If public opinion can bring the Government to take the major decisions of policy which are necessary to enable local authorities to go ahead with their planning, and if scientific workers see to it that research in regard to materials and methods at the technical level and the social level in regard to the needs of the home and of the community is prosecuted with vigour, with vision, and with adequate resources, there is no reason to doubt the ability of the country to seize the opportunity which is now arising in building, in housing and in planning.

THE FŒTAL CIRCULATION

The Foetal Circulation and Cardiovascular System and the Changes that they Undergo at Birth

By Dr Alfred E Barclay, Dr Kenneth J Franklin and Marjorie M L Prichard Pp xvi+275 (Oxford Blackwell's Scientific Publications, Ltd, 1944) 50s net

OF all the foetal systems, the cardiovascular has been the most provocative of theorizing. Its anatomy is linked with such names as Galen, Fallopius, Vesalius, Harvey, Lower, His, Born and Tandler in its physiology with Galen, Harvey, Méry, Wolf, Haller and Sabatier. As regards the experimental approach, Wilhelm Preyer's masterly work, "Speziell Physiologie des Embryo" (1885), still remain unique.

In this volume Barclay, Franklin and Prichard with due recognition of their Cambridge colleagues Barcroft and Barron, present an account of their combined work with emphasis on that part which has been the more direct concern of the Oxford team. The manner in which the problem has been approached and the technical details overcome will command the respect and admiration of all, for, as the authors state, "it consists of an account of our own foetal studies".

The first part, a historical survey, is followed by an account of the course of the blood through the foetal heart of the lamb as seen radiographically, including résumé of the technique and apparatus used. The third part deals with the anatomy and physiology of the circulation in the lamb foetus, and the neonatal changes. The comparative anatomy and physiology of the foetal cardiovascular system, mostly original work of the authors, constitute the fourth part of the book. Four chapters on the human cardiovascular system, with the speculations of the authors on the foetal circulation in man, form the fifth part of the volume, which concludes with a brief summary and anticipations of the period when the work may be extended to the human foetus.

The contributions of anatomists and physiologists from the time of Galen are recorded and assessed. Attention is again directed to the appropriation of the discovery of the ductus arteriosus and the foramen ovale (both known to Galen) by Botallo, and to the priority, often erroneously accorded to Arantius, for the discovery of the ductus venosus, already known to his teacher, Vesalius. Harvey's contribution is dealt with in great detail. Wolff's work receives recognition which it duly deserves. He undoubtedly had a clear idea of the anatomical relations of the channels in the foetal heart and obtained a more accurate insight into the foetal circulation than any of his predecessors. The technical errors of Kellogg and Pohlmann are discussed, together with the inaccuracies of their interpretations. Among the more recent experimental work on the foetal circulation the omission of that of Huggett is surprising. Indeed, his name does not appear in the whole volume. The authors credit Kellogg with the first experiments on the foetus delivered by Caesarean section, with the placental circulation intact and foetal respiration inhibited. Huggett's first paper on the tension of the blood gases in the foetus, with description of his technique, appeared in 1927 (*J. Physiol.*, 62), antedating Kellogg's first paper (1928 *Amer. J. Anat.*, not *Anat. Rec.*) by more than eighteen months.

Part 2 is devoted to the actual course of the blood in the foetal lamb as visualized by cine-radiography following the injection of opaque media into the circulation at various critical points. This part of the volume will undoubtedly receive the admiration of all who read it. The description, the twenty-eight figures and the four excellent frames of actual cinematographic records deserve the highest praise. It is the first depiction of the blood flow in the foetal circulation under conditions approximating to those within the amniotic cavity. The division of the post-caval blood stream on the annulus fossæ ovalis, which the authors prefer to call the crista dividens, is described.

In the chapter on the cardiovascular system of the lamb the authors introduce new functional terms for the older and more established anatomical ones. Whether this change of terminology should be adopted is doubtful. Physiological discoveries must undoubtedly call for a constant revision and extension of terminology, but the term introduced must also be acceptable to those seeking to explain the mechanisms of morphological changes in the embryo and foetus. For example, the authors suggest the name 'umbilical venæ comites' for the paired umbilical veins in the cord, as distinct from umbilical vein or the unpaired structure within the abdomen. The evolution of right and left umbilical veins, primarily paired veins, is disregarded here. In the marsupials, McClure has named the fused umbilical veins within the abdomen the umbilical sinus. Umbilical venæ comites seems scarcely justifiable. On the grounds of priority, the authors dissociate the name of Arantius from the term ductus venosus. The particular channel so admirably described by Arantius in the human and its homologue in other mammals must be distinguished from other channels similarly named. Tribe, in her paper on the hepatic venous system, gives a translation by Thane of the original description by Arantius: "So that if you introduce a probe into the umbilical vein you will arrive in the trunk of the portal vein and then by means of the said communication (*the ductus venosus*) straight into the vena cava." Hill and Tribe prefer to retain the term ductus venosus Arantii for this type of channel, and to use the unqualified term ductus venosus for the channel connecting the vitelline vein with the postcaval vein. There is some justification for retaining the name of Arantius for this type of ductus venosus, if only by virtue of the clarity of the original description in 1564.

The comparative studies dealt with in Part 4 are fragmentary, but extremely valuable and stimulating. Discussion of the placenta is brief and follows the lines of Grosser's classification, the only one of value to both physiologist and embryologist. In many ways the sheep's placenta, despite the classical work of Assheton on the ungulate placenta, may still be termed, like the spleen, *organon plenum mysterium*.

The umbilical cord, despite its apparent simplicity, affords many unsolved problems. Of the smaller blood vessels in the stroma of the cord, the authors say little, and have omitted the observations of Wislocki, who credits Klaatsch with the first description of these vessels. It would appear that man and primates have an avascular stroma, while other mammals possess a capillary plexus. Except for its most proximal segment, capillary channels occur in the primate cord only during the early stages of formation of the paired umbilical arteries and veins. The authors consider that the vessels can scarcely be

the vasa vasorum of the umbilical vessels, but do not mention Wislocki's view that they may be the vasa propria of the stroma. Of the blood vessels in the proximal portion of the human cord, they have little to add to that already written, but it is obvious that little is known of the nutrition of the umbilical cord, of the vascular plexus in the proximal segment of the human cord, or of the para-umbilical veins. Of the strength and site of rupture of the cord, it is doubtful if many would subscribe to the views of Shordania, for the site of rupture in the human is generally at or close to the umbilicus. The irritability of the umbilical vessels and their 'valves' are adequately considered so far as existing knowledge permits. One of the valuable features of this section of the book is that attention is forcibly directed to the series of unsolved problems in so simple an organ as the cord.

The territorial distribution of the umbilical and portal veins in the liver during foetal life follows Mall's classical work on the liver lobule and the rather wider approach of Charnock Bradley. It is difficult to correlate the work that has been done on this aspect of the foetal liver. It is surprising that the work of Bonne (1904) has not received the attention of the authors, since this was done on the foetal liver in sheep and his results closely resemble theirs.

The tissue surrounding the 'sphincter' on the ductus venosus is described as 'oedematous'. This word implies a pathological state. The oedematous tissue is the normal loose areolar tissue of the type seen near contractile and expansile organs.

In the light of the authors' radiographic work, their 'via sinistra' (valve of foramen ovale) and 'via dextra' (right moiety of the postcaval channel) are carefully described in sheep and man. Little seems to be known of the functional closure of the via sinistra or of the ductus arteriosus, other than that provided by the work of this team.

The neonatal and postnatal changes in these transient channels have been studied microscopically by many anatomists, but the authors rightly omit these. Observations on the onset of respiration in sheep are discussed with reference to Barcroft's views. Huggett's prior observations on respiration following delivery of the goat foetus are omitted. The statements about parturition in captive animals are not enlightening. Our knowledge of parturition in primates is meagre, but the position is being clarified by Elder and Yerkes in chimpanzees and by Hartmann in the macaque, reference to whom has been omitted. Of the actual time of birth the authors state, "Almost all primate births occur at night." Elder and Yerkes state the opposite. Concerning placentophagia in the primates, the experience of Dr Ververs quoted here seems to be at variance with that of Hartmann and Elder and Yerkes. Hartmann states, "all deciduate mammals except man if left to themselves will eat the afterbirth and this holds for the herbivores." In the one series of chimpanzee births recorded by Elder and Yerkes, seventeen out of twenty-nine ate all or part of the placenta. They state that under natural conditions the percentage of placentophagia would probably have been considerably higher.

In Part 5 the authors attempt "to know better what happens in the human subject." In applying their results in sheep to the human, they have been justifiably cautious but effective. There is much support for the view that the circulation in the human is not dissimilar to that in the sheep. They

look to the time when more direct evidence of the changes occurring at birth in the human cardiovascular system will be available

The foregoing criticisms must not be allowed to detract from the value of this publication. It is full of information and is the most comprehensive and satisfying account in existence of the foetal circulation and its neonatal changes. The work done by this team should command the admiration of all interested in the young mammal. The gaps in our knowledge are clearly enunciated and should act as a stimulus to embryologists, obstetricians and physiologists alike. The numerous illustrations are of high quality, the bibliography and index most useful. The authors, publishers and the Nuffield Institute for Medical Research alike deserve credit and thanks for producing so monumental a treatise in war-time.

D V DAVIES

TRAVELS OF A BOTANIST

A Life of Travels

By C S Rafinesque. Being a verbatim and literatim reprint of the original and only edition (Philadelphia, 1836). Foreword by Elmer D Merrill, Critical Index by Francis W Pennell (Chronica Botanica, Vol 8, No 2). Pp 291-360+plates 5-8 (Waltham, Mass Chronica Botanica Company, London Wm Dawson and Sons, Ltd, 1944) 2 50 dollars

RAFINESQUE was a peculiar character who, in the course of a vagrant life of fifty-seven years, worked according to himself as "a Botanist, Naturalist, Geologist, Geographer, Historian, Poet, Philosopher, Philologist, Economist and Philanthropist". But primarily he was a plant taxonomist, whose work Dr Merrill suggests in the foreword to this volume, has not received the attention that it deserves.

Rafinesque was born "at Galata, a suburb of Constantinople", in 1783, and died in Philadelphia in 1840. With the exception of a period of ten years in Sicily, most of his adult life was spent in America. He was apparently an indefatigable traveller, who made long laborious journeys "by nearly all the possible manners except by camels and in balloons". He was also an extremely zealous collector, so much so that of one episode he writes "In wading through Green R. I narrowly escaped drowning, but collected many fine shells". In the intervals between the successive journeys he led a busy life writing books, maintaining an elaborate correspondence with many of the leading naturalists of his day, and earning his living. Unfortunately in this last undertaking he was not very successful. On one occasion some of his collections "remained for a while in store and under a mortgage", and repeatedly in the account of his travels he complains of the duplicity of those who would not recognize his just financial claims. At one time he earned his living as a teacher of Italian, drawing and botany, later he was appointed to a "Professorship of Botany and Natural history, with the addition of modern languages, with lodgings, boarding and casual emoluments", and later still he became "a Pulmist, who attended only to the diseases of the lungs, as a Dentist attends only to the teeth". And again towards the end of his life he became "the Actuary" for an institution that was born of his own ingenuity, "The Divital Institution and six per cent Savings Bank".

These details are given in "A Life of Travels", which was first published in Philadelphia in 1836,

and which has now been reprinted in this edition. The passages in which they are recorded, however, are only occasional interpolations in an arid recital of places visited and routes followed. Throughout there is little description either of the observations or of the collections made during the several journeys. There are a few incidental comments, but these are not expressed with any particular originality. For example, of himself, Rafinesque writes "I never was happier than when alone in the woods, or resting near a limpid stream or spring, I enjoyed without contro the gifts of Flora, and the beauties of Nature". Nevertheless, the journeys that are described in such minute detail are of considerable interest in relation to the taxonomic work that was based on them, and to that extent the publication of the present volume is fully justified. Evidently this edition has been prepared with considerable care, but since itineraries are a prominent feature of the text, the value of any future edition would be considerably enhanced by the provision of illustrative maps, of which there is none in this.

R BROWN

PHOTOGRAPHY OF THE RECIPROCAL LATTICE

The Photography of the Reciprocal Lattice

By M J Buerger (ASXRED Monograph No 1 published by the American Society for X-Ray and Electron Diffraction). Pp ix+37 (Cambridge Mass Murray Printing Co, 1944) 1 50 dollars

NOT many years ago an account of single-crystal X-ray diffraction methods would have been considered complete if it had referred only to the Laue, rotation and oscillation methods, with particular emphasis on the last. There might also have been some mention of moving-film methods, such as the Weissenberg. All this is now changed. Moving film methods bid fair to displace other methods completely, even for the study of polycrystalline aggregates.

Prof Buerger's book adds another chapter to the use of these methods, he has been able to devise apparatus whereby sections of the reciprocal lattice—the representation of the diffraction pattern of a crystal—can be obtained without distortion. In other words, the indices of the X-ray reflexions can be read off without the use of charts, with a consequent saving of time and an increase in reliability.

The book gives full details of the theory of the apparatus and contains several beautiful examples of photographs taken with its use. The author also gives a very fair estimate of the advantages and disadvantages compared with other methods. In particular, it will not give part of the reciprocal lattice near the origin, in common with all methods except the equi-inclination Weissenberg.

There are a few criticisms that can be made. The author claims that the method is inherently more accurate than most other moving-film methods, but he does not give a clear statement of the accuracy that can be expected from it. Also the title of the book is misleading, all methods that use characteristic radiation give a representation of the reciprocal lattice. These, however, are small points, and the American Society for X-Ray and Electron Diffraction is to be congratulated on the first of the monograph it has produced.

H LIPSON

PLANT-GROWTH SUBSTANCES AS SELECTIVE WEED-KILLERS

Differential Effect of Plant-Growth Substances on Plant Species

STUDIES of the effect of growth substances upon plants began at Jealott's Hill Research Station in 1936. The earliest work dealt with the stimulation of the rooting of cuttings and it was extended to discover the effect of ranges of concentrations of 3-indolylacetic acid and α -naphthylacetic acid upon seed germination, upon seedling growth and upon the growth of established plants of many species. The results of these experiments have already been reported^{1,2}, and in them it was observed that the higher concentrations of growth substance depressed growth. This observation, together with our knowledge of the variation of the extent of rooting and deformative effects produced in the different species, led us to expect that these growth substances in higher concentrations would show a selective phytocidal action. We found in August 1940 that applications at the rate of 15 lb of α -naphthylacetic acid per acre to oats (*Avena sativa* L.) weedy with yellow charlock (*Brassica sinapis* Visianii) killed the charlock. The oats only received a slight setback and recovered fully. The application was made just after seed-sowing time. 4 per cent of the charlock failed to germinate, and those seedlings which did emerge afterwards died. Several experiments in soil and sand and upon filter paper in the laboratory confirmed these results and indicated that wheat, barley and rye behaved similarly to oats, while greater plantain (*Plantago major* L.) and yarrow (*Achillea millefolium* L.) were like yellow charlock in their responses.

Thus, we had confirmed our expectation of selective phytocidal action of certain growth substances, for indolylacetic acid and α -naphthylacetic acid killed some major weeds in cereal crops without harming the cereals, wheat, oats and barley. We followed up this lead by experimenting with other growth substances. For if growth substances were to be of use to the farmer as selective weed-killers, it was necessary to find one which was cheaper than or much more active than α -naphthylacetic acid. We already knew plant-growth action was not characterized by a close degree of correlation with chemical constitution, and consequently we made a chemical survey of known growth substances and substances structurally related to them. Substituted phenoxyacetic acids and naphthoxyacetic acids were found to be outstanding and certain of them were found to be fifty times as active as α -naphthylacetic acid. The following list shows some of the compounds tested.

Class A Activity greater than α -naphthylacetic acid

o-methyl-phenoxyacetic acid (Na salt)
m-methyl-phenoxyacetic acid
p-methyl-phenoxyacetic acid
2,4-dimethyl-phenoxyacetic acid
2,5-dimethyl-phenoxyacetic acid
3,4-dimethyl-phenoxyacetic acid
p-chloro-phenoxyacetic acid (Na salt)
2,4-dichloro-phenoxyacetic acid
2,5-dichloro-phenoxyacetic acid
4-chloro-2-methyl-phenoxyacetic acid
4-chloro-3-methyl-phenoxyacetic acid
 β -naphthoxyacetic acid (Na salt)
2,4-dichloro- β -naphthoxyacetic acid (Na salt)
methyl- β -naphthoxyacetate
propyl(n)- β -naphthoxyacetate
propyl(iso)- β -naphthoxyacetate
butyl(iso)- β -naphthoxyacetate

Class B Activity approximately equal to α -naphthylacetic acid

o-chloro-phenoxyacetic acid (Na salt)
2,4,6-trichloro-phenoxyacetic acid (Na salt)
ar-tetrahydro- β -naphthoxyacetic acid
 β -naphthoxyacetamide
 β -naphthoxyacetonitrile
ethyl- β -naphthoxyacetate
butyl(n)- β -naphthoxyacetate
cyclohexyl- β -naphthoxyacetate

Class C Some activity

phenoxyacetic acid
p-nitro-phenoxyacetic acid (Na salt)
2,4-dinitro-phenoxyacetic acid (Na salt)
 α -naphthoxyacetic acid (Na salt)
1-chloro-2-naphthoxyacetic acid (Na salt)
2-chloro-1-naphthoxyacetic acid (Na salt)
ethyl- α -naphthoxyacetate

Experiments carried out in November 1941 showed that 4-chloro-2-methyl-phenoxyacetic acid was one of the most active compounds tested, and that it readily depressed the germination and early seedling growth of corn buttercup (*Ranunculus arvensis* L.), fat hen (*Chenopodium album* L.), corn marigold (*Chrysanthemum segetum* L.), corn spurrey (*Spergula arvensis* L.) and field poppy (*Papaver Rhoeas* L.) at concentrations which were without effect on cereals. Pot and field experiments showed that germination of yellow charlock was suppressed and plants at any stage from seedling to flowering were readily killed by spraying with solutions of sodium 4-chloro-2-methyl-phenoxyacetate supplying only 10 mgm per square foot (equivalent to approximately 1 lb per acre) of active principle. The affected plants showed marked epinasty and died slowly. The substance appears to persist in the soil for several weeks. Work is at present in progress to extend our knowledge of this effect and to gather information on the underlying causes. In view of the very low concentrations of these substances which bring about such marked differences, it is possible that such materials present or produced in soils may have big influences on the nature and composition of the plant associations growing upon them.

In November 1942 we communicated all our knowledge on selective weed-killers to the late Dr W. C. Topley, secretary of the Agricultural Research Council, and from that date we have co-operated with Dr J. H. Quastel, Dr H. G. Thornton, Dr P. S. Nuttman and Mr G. E. Blackman.

In 1943 a field trial showed that sodium 4-chloro-2-methyl-phenoxyacetate applied at 1 lb/acre gave 100 per cent eradication of yellow charlock in spring oats without damaging the cereal, and equally good results were obtained if application was made when the weeds were small or when they were in full flower.

We carried out a further programme of field experiments in 1944 which have confirmed and amplified the earlier results. Yellow charlock (*Brassica Sinapis Visianii*), white charlock (*Raphanus Raphanistrum* L.), corn buttercup (*Ranunculus arvensis* L.) and pennycress (*Thlaspi arvense* L.) have all been eradicated from cereal crops by 1 lb/acre applied as a spray in 100 gallons/acre of water. If the application was made in a dry form using china clay as a diluent, 2 lb/acre of active principle gave similar results with these weeds. There are differences in the sensitivity of weeds, for example, mayweed (*Anthemis Cotula* L.) appears to be somewhat resistant. It is evident that sodium 4-chloro-2-methyl-phenoxyacetate is effective whether absorbed through the root or leaf of the weed and can be used to prevent seed germination of the weeds specified above as well as to destroy established plants. This material is also non-corrosive. Further research is being done

to elucidate the usefulness of this material for a variety of weeds and crops

Full details of this work are being published elsewhere

Suggestions that synthetic growth substances might be used as selective weed-killers have been made recently and independently by Beal³, Mitchell and Hamner⁴ and by Hamner and Tukey⁵

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¹ Templeman, W. G., *Emp. J. Exp. Agric.*, 7, 76 (1939)

² Templeman, W. G., and Marmoy, C. J., *Ann. App. Biol.*, 27, 453 (1940)

³ Beal, J. M., *Bot. Gaz.*, 105, 47 (1944)

⁴ Mitchell, J. W., and Hamner, C. L., *Bot. Gaz.*, 105, 474 (1944)

⁵ Hamner, C. L., and Tukey, H. B., *Science*, 100, 154 (1944)

Inhibition of Plant Growth by 2:4-Dichlorophenoxyacetic Acid and other Plant-Growth Substances

THE work on this subject began at Rothamsted in November 1941 as a result of the previous study of the deformation of legume root hairs made by H. K. Chen, which indicated that the curling of root hairs by *Rhizobium* was due to the secretion by the latter of β -indolylacetic acid. Our first experiments were intended to discover whether a similar deformation of root hairs could be induced by β -indolylacetic acid itself and by related plant stimulants

In these and in subsequent experiments, where agar was used, a basal medium was employed having the following percentage composition: K_2HPO_4 , 0.05, KH_2PO_4 , 0.05, $Ca_3(PO_4)_2$, 2.0, $FePO_4$, 0.5, $MgSO_4 \cdot 7H_2O$, 0.02, $NaCl$, 0.01, $FeCl_3$, 0.001, KNO_3 , 0.1, agar, 1.5. This medium was put up in test tubes, sterilized, and appropriate dilutions of the compounds to be tested were separately sterilized and added aseptically to the melted medium. Slopes were then made and two seeds of the test plant, externally sterilized by successive immersion in 80 per cent alcohol and 0.2 per cent mercuric chloride and washed in sterile water, were placed at the top of the slope in each tube.

In our early experiments we found that β -indolylacetic acid and α -naphthylacetic acid both produced marked root-hair deformation in the agar cultures of red clover, in the absence of *Rhizobium*. But it was also found that both compounds were toxic to germination and to subsequent growth at dilutions up to 1 in 10,000,000. Results of a typical experiment are given in Table 1.

In view of the possibility that tryptophane may be the parent source of β -indolylacetic acid produced by *Rhizobium*, the toxic action of tryptophane itself was tested. Results showed that, in sterile agar medium, tryptophane exerted a toxic action to red clover at concentrations of more than 10 parts per million, but that where *Rhizobium* was also present, the limit of toxicity was lowered to 1 part per million. These results support Thimann's¹ and Chen's² evidence, indicating that this organism is able to produce β -indolylacetic acid from tryptophane.

TABLE 1 TOXIC ACTION OF GROWTH SUBSTANCES ON RED CLOVER

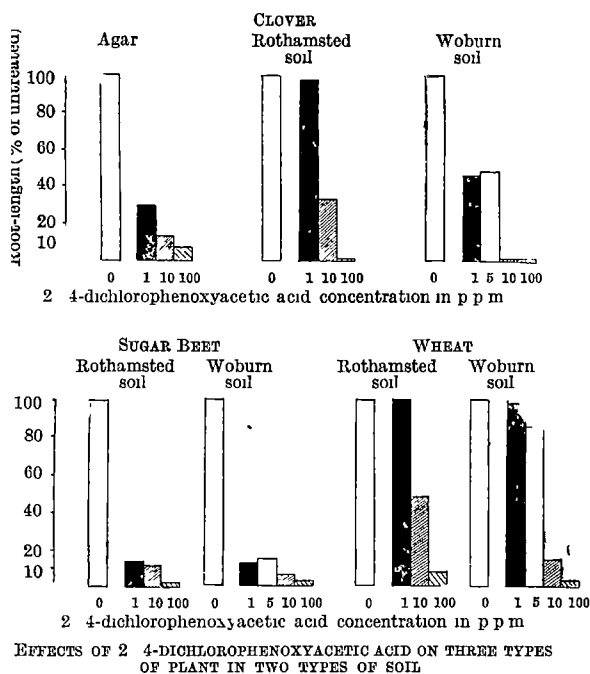
Compound	Concentration in p.p.m.	Total seeds sown	Germination affected	Subsequent growth affected	Normal seedlings
β -Indolylacetic acid	100	15	15	0	0
	10	15	12	2	1
	1	15	8	4	5
	0.1	12	0	11	1
α -Naphthylacetic acid	100	15	15	0	0
	10	15	15	0	0
	1	15	5	9	1
	0.1	15	4	8	3
Control	0	15	2	0	13

The high toxicity of β -indolylacetic acid and α -naphthylacetic acid suggested the possibility of using such compounds for controlling plant-growth. We therefore made an experiment to determine whether the above compounds were equally toxic to other plants and whether toxicity was affected by conditions in soil. In this experiment we tested the two compounds at 10, 1 and 0.1 parts per million in the agar medium, or the soil solution, on red clover, lucerne, and mustard, and, in addition, β -indolylacetic acid on wheat. We made the tests in agar medium and in unsterilized Rothamsted soil. In the agar medium, β -indolylacetic acid was toxic to clover and lucerne at concentrations down to 0.1 part per million, and to mustard to 1 part per million, whereas wheat was affected only at 10 parts per million. α -Naphthylacetic acid was toxic to clover and lucerne at 0.1 part per million and to mustard at 1 part per million. In unsterilized soil, however, neither compound showed any toxicity except at the highest concentration of 10 parts per million, where there was a slight effect. A further experiment showed that the toxicity of β -indolylacetic acid remained in sterile soil though its loss in unsterilized soil was confirmed.

We concluded that neither compound would be of practical use for controlling plant growth in natural soil owing to the loss of its toxic action, probably through decomposition by soil micro-organisms. We therefore sought for a molecule of comparable toxicity, less liable to microbial attack. In view of the known activities of phenoxyacetic acids as plant stimulants, and the likelihood that chlorinate compounds would be resistant to bacterial action, we decided to investigate the comparative toxicity in agar and in unsterilized soil of 2:4-dichlorophenoxyacetic acid. We therefore made tests, in October 1942, on red clover, using 2:4-dichlorophenoxyacetic acid as well as the related compounds α -naphthoxyacetic acid and the methyl esters of α - and β -naphthyl

TABLE 2 EFFECTS OF VARIOUS COMPOUNDS ON ROOT LENGTH IN OM RED CLOVER IN AGAR AND IN WOBURN SOIL

Compound	Concentration in p.p.m. of the agar medium and the soil solution			
	in agar		in soil	
	1	100	1	100
α -Naphthylacetic acid	7.7	2.4	—	5.2
2,4-Dichlorophenoxyacetic acid	1.1	0.6	2.0	0.3
Methyl ester of α -naphthoxyacetic acid	7.2	0.3	—	6.7
Methyl ester of β -naphthoxyacetic acid	5.7	2.1	8.0	3.6
Methyl ester of phenoxyacetic acid	5.6	7.1	—	7.9
Control	7.9		6.8	



xyacetic acids and phenoxyacetic acid, the last three compounds being included to test the effect of esterification. The results are given in Table 2.

4-Dichlorophenoxyacetic acid was much the most toxic of the compounds tested and, unlike the others, retained its toxicity to a satisfactory extent in sterilized soil. We also noticed that its action, though affecting germination and top growth, showed most strikingly in its stunting effect on root growth. We therefore took root-length as a measure of toxicity.

The action of 2,4-dichlorophenoxyacetic acid in sterilized soils of two widely different types and towards different types of plant was then tested. The test was made on red clover, sugar beet and wheat in test-tubes containing (1) Woburn soil, a light sand low in organic matter, and (2) Rothamsted allotment soil, a clay loam rich in organic matter. The clover was also tested in the agar medium. The 2,4-dichlorophenoxyacetic acid was added in concentrations giving 1 to 100 parts per million in the soil solution. The diagram above shows the relative mean root-lengths from nine replicates, after four weeks growth, expressed as percentages of those in control plants. In Woburn soil 2,4-dichlorophenoxyacetic acid was strongly toxic to clover and especially to sugar beet, even at 1 part per million. Wheat, however, was not appreciably affected at the lower concentrations, though marked toxicity appeared at 10 parts per

million. In the Rothamsted soil, toxicity towards clover and wheat was less marked, although the action on sugar beet was again very striking. In this soil also, wheat was the least affected of the three plants. In a further test on Woburn soil, we found that the addition of 0.1 per cent of potassium nitrate had no effect on the toxicity of 2,4-dichlorophenoxyacetic acid over the same range of concentrations.

We then tested the persistence of the toxicity of 2,4-dichlorophenoxyacetic acid in unsterilized soil. The compound was added to Woburn soil in test tubes, at concentrations of 1, 10 and 100 parts per million of the soil solution with untreated controls. These tubes were stored for thirty-six days, after which a second set of tubes with similar treatments was set up and both sets were then sown with red clover. Table 3 shows the mean root-lengths (from nine replicates) after four weeks growth. The usual toxicity was shown in the tubes sown immediately after adding 2,4-dichlorophenoxyacetic acid, but storage had completely removed the toxicity.

The action of leaching on 2,4-dichlorophenoxyacetic acid in Rothamsted allotment soil was then tested. Air-dry soil was put up in two sets of 10 cm. glass pots. One set was allowed to take up water and the second a solution of 10 parts per million of 2,4-dichlorophenoxyacetic acid, up to saturation capacity. During the following three days, pots of each set were given 2, 4 and 8 successive leachings, equivalent respectively to the slow percolation at 1.4, 2.8 and 5.6 in. of water. Control unleached pots of each set were kept. After the leachings, the surface of each pot was sown with clover, sugar beet and wheat, and the pots were then normally watered. The results of this test showed that leaching equivalent to 1.4 in. of water produced a reduction in toxicity that was just significant, while even that equivalent to 5.6 in. failed to remove all the toxic effect.

Discussion. The action of 2,4-dichlorophenoxyacetic acid on the plant varies according to concentration from complete inhibition of germination to a stunting of the root system and dwarfing of the leaves. This effect on the roots is accompanied by a marked thickening of the cortex and also, in certain cases, by the development of numerous short laterals. The formative effects noted by Zimmerman and Hitchcock³ were also shown in clover chiefly by the multiplication and displacement of the leaflets and by inflation of the petiole. The macroscopic symptoms were similar to those produced by β -indolyl- and α -naphthylacetic acids.

Problems of great physiological interest are raised by the fact that these compounds, which are known to stimulate extension growth and to have profound developmental effects, are also toxic to the whole plant in doses of 0.1–1.0 part per million. 2,4-Dichlorophenoxyacetic acid, however, differs from such compounds as β -indolyl- and α -naphthylacetic acids in that it persists long enough in unsterilized soil to produce marked toxic effects. These effects show at a concentration of 1 part per million of soil solution, equivalent to 1 part in 4 millions of soil at 25 per cent moisture, representing on a field-scale about $\frac{1}{2}$ lb. per acre of soil to 6 in. depth. It would thus seem that this compound should be of use in controlling plant-growth. It is not readily leached from soil but yet possesses the advantage of ultimately losing its toxicity, thus it would be unlikely to poison the land. The fact that

TABLE 3. TOXICITY OF 2,4-DICHLOROPHENOXYACETIC ACID TO RED CLOVER WHEN SOWN IMMEDIATELY, AND AFTER 36 DAYS FROM TIME OF ADDING THE COMPOUND TO UNSTERILIZED WOBURN SOIL.

Concentration in p.p.m. of soil solution	Seedling root-length (cm.)	
	Sown immediately after addition of compound to soil	Sown 36 days after addition of compound to soil
100	0.0	8.2
10	0.0	8.5
1	3.8	8.4
Control 0	7.6	8.3

different types of plants vary greatly in susceptibility to its toxic action may here be of considerable practical importance

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¹ Thimann, K V, *Proc U S Nat Acad Sci*, 22, 511 (1936)

² Chen, H K, *Nature*, 142, 753 (1938)

³ Zimmerman, P W, and Hitchcock, A E, *Cont Boyce Thompson Inst*, 12, 321 (1942)

A. Comparison of Certain Plant-Growth Substances with other Selective Herbicides

With grants from the Agricultural Research Council, a research team at the Imperial College of Science and Technology has been engaged in studying the general problem of weed eradication by chemical methods. Since April 1943, 4-chloro-2-methyl-phenoxyacetic acid and 2,4-dichlorophenoxyacetic acid have been included in the investigations. Their performance under field conditions has been compared with other herbicides in some forty-eight experiments involving more than 3,000 plots.

Special attention has been given to the control of annual weeds in cereal crops. In particular, a comparison has been made of the two phenoxyacetic acid derivatives with copper chloride, sulphuric acid and either a suspension of dinitro-*ortho*-cresol or a solution of the ammonium salt. When the spray concentrations—at the standard rate of 100 gallons per acre—are kept within the limits at which each herbicide is truly 'selective', then a feature of the results is the specific action of the several herbicides on different weed species.

The reactions of the chief annual weeds investigated are summarized in the accompanying table. It is seen that whereas for some weeds such as *Brassica arvensis* or *Thlaspi arvense* several herbicides are capable of giving a high degree of control, for other species like *Scandix Pecten-Veneris* or *Matricaria inodora* one compound is alone effective. Moreover, copper chloride and sodium 4-chloro-2-methyl-phenoxyacetate are more specific than dinitro-*ortho*-cresol in the narrower range of weeds they can destroy or partially control.

Following on weed suppression, increases in the yield of grain up to 90 per cent have been recorded. There is no indication that dinitro-*ortho*-cresol at the concentrations required for weed control (0.3–1.2 per cent) has checked growth. Both copper chloride at the higher concentrations (3–4 per cent) and sulphuric acid (9–18 per cent) have given smaller increases in yield. 4-chloro-2-methyl-phenoxyacetic acid, over a range of 0.025–0.25 per cent, has no adverse effect on spring- and autumn-sown cereals, but at higher concentrations it may cause a reduction in yield of spring oats and barley. The evidence to date is that 2,4-dichlorophenoxyacetic acid is less selective in its action and is more likely to injure the crop.

The phenoxyacetic acid derivatives are outstanding in that they can operate through absorption by both the shoot or the root. In consequence, germination of weed seedlings in the soil may be suppressed for some weeks after application. The suppression of

RELATIVE EFFECTIVENESS OF CUPRIC CHLORIDE, AMMONIUM DINITRO-*ortho*-CRESOL, SODIUM 4-CHLORO-2-METHYL-PHENOXYACETATE AND SULPHURIC ACID FOR THE CONTROL OF ANNUAL WEEDS

Degree of control

+++ more than 90% ++ more than 75% + more than 50%
R = resistant—less than 50% control

Weed species	Cupric chloride	Ammonium dinitro- <i>ortho</i> -cresylate	Na 4-chloro-2-methyl-phenoxyacetate	Sulphuric acid
<i>Brassica arvensis</i> (yellow charlock)	+++	+++	+++	++
<i>Raphanus raphanistrum</i> (white charlock)	++	++	+++	++
<i>Thlaspi arvense</i> (penwycress)	+++	+++	+++	++
<i>Erysimum cheiranthoides</i> (treacle mustard)	+++	+++	+++	+++
<i>Atriplex patula</i> (goosefoot)	R	+++	(R)*	++
<i>Chenopodium album</i> (fat hen)	R	+++	R	++
<i>Matricaria inodora</i> (scentless mayweed)	R	+++	R	+
<i>Matricaria Chamomilla</i> (chamomile)	R	+++	R	+
<i>Centaurea Cyanus</i> (cornflower)	R	++	+++	+
<i>Polygonum aviculare</i> (knotgrass)	R	+	R	+
<i>Polygonum Convolvulus</i> (beardbind)	+++	++	+	+++
<i>Scandix Pecten-Veneris</i> (Venus' comb)	R	+	+++	+
<i>Papaver Rhoeas</i> (corn poppy)	R	+++	++	R
<i>Fumaria officinalis</i> (fumitory)	R	+++	(R)	R
<i>Achillea arvensis</i> (parsley piert)	R	+++	R	+++
<i>Ranunculus arvensis</i> (corn buttercup)	R	++	+++	+
<i>Spergula arvensis</i> (spurrey)	+	++	+	+++
<i>Galeopsis Tetrahit</i> (hemp nettle)	+	+++	+++	+++
<i>Veronica hederifolia</i> (ivy-leaved speedwell)	++	+	+++	+++

* Brackets indicate that category is tentative

B. arvensis and *E. cheiranthoides* has been obtained with amounts of 0.5–1.0 lb per acre, but for other species, such as *Polygonum Persicaria* (willow weed), there is no inhibiting effect. The minimal quantity required to kill susceptible weeds, once they have emerged through the soil, is less—an almost complete control of *B. arvensis* has been obtained at a spray concentration equivalent to 4 oz. per acre of the sodium salt.

In addition to the investigation of cereal crops, the research has been extended to cover annual weed control in grasses, clovers, etc., for seed production in flax and linseed, peas, onions, leeks, and perennial weeds in grassland. With grasses, once the seedling stage is passed, sulphuric acid, cupric chloride, dinitro-*ortho*-cresol and 4-chloro-2-methyl-phenoxyacetic acid can be employed for the destruction of annual weeds. The clovers in the early stages are either killed or severely checked by such spray treatments, though they are somewhat more resistant when fully established.

In flax, copper chloride and the sodium salt of dinitro-*ortho*-cresol have given the most promising results. The ammonium salt causes serious crop injury. 4-chloro-2-methyl-phenoxyacetic acid, although it may in no way affect the straw or seed yield of flax, will bring about a reduction in fibre yield. The extent of the reduction is dependent on the concentration and the time of spraying. Only sulphuric acid and cupric chloride can be employed in onion and leek crops for selective weed control. Dinitro-*ortho*-cresol compounds and the phenoxy

acetic acid derivatives are toxic. Preliminary trials suggest that maize is resistant to some dinitro-*ortho*-cresol compounds, and 4-chloro-2-methyl-phenoxy-acetic acid.

The phenoxyacetic acid derivatives are again exceptional in that they alone show promise for the control of some perennial weeds. In established grassland the experiments indicate that 4-chloro-2-methyl-phenoxyacetic acid, at concentrations which do not kill out *Trifolium repens*, from a single spraying, will destroy buttercups (*Ranunculus* spp.), *Equisetum arvense* (horsetail) and partially suppress *Cirsium arvense* (creeping thistle). At these levels of concentrations—up to 2.5 lb. per acre—*Rumex* spp. (docks), *Urtica dioica* (stinging nettle) and *Pteris aquilina* (bracken) are resistant.

The following members of the team have taken part in these investigations: A. J. Rutter, J. Carpenter, H. Wild, B. G. Goodey, J. L. Crosby, C. P. Whittingham, P. A. Tallentire, A. C. Crundwell, P. Greig-Smith, J. C. Gimingham.

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ARTIFICIAL PROTEIN FIBRES: THEIR CONCEPTION AND PREPARATION

By DR. W. T. ASTEURY, F.R.S.

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A PRINCIPAL aim of science in relation to industry is to elucidate for the industrialist the nature of his working materials. All fundamental research into the structure and properties of things is therefore of potential value to industry; but this is a platitude to the man of science. To the non-scientific majority, however, it is not yet so obvious, and it is still regrettably necessary to make play with the more spectacular discoveries in order to attract proper support for research.

A recent development that has captured the imagination of the public is the discovery how to make artificial protein fibres from nuts, beans, milk, and other not visibly fibrous protein sources, and the official announcement during December 1944 by Imperial Chemical Industries, Ltd., of the successful production of 'Ardil' from the protein of pea-nuts suggests an occasion for briefly re-telling the story, but this time more from the fundamental point of view than has been possible in the popular accounts that have appeared. I have no intention here of labouring the theme of what industry owes to science, or vice versa, or of emphasizing again that the great industries of the future must draw their sustenance from unremitting research; but I would certainly like to stress the case of the artificial protein fibres as being a most impressive example of the indivisibility of science. The discovery of the underlying principles was of purely academic origin, an outcome of X-ray and related studies of the molecular structure of biological tissues—studies that were neither supported by nor consciously dedicated to industry; the basic experiments were compounded of physics, chemistry, and biology, and were carried out in a university. Thereafter the development to com-

mercial satisfaction was the work of industrial chemists and technologists.

It is not claimed, of course, that artificial protein fibres had never been produced previously—indeed, it happens that the casein fibre, 'Lanital', for example, was launched in Italy at almost the same time as the quite independent fundamental investigations about to be described were pointing the way to the general solution of the problem—but it is clear that in the absence of any structural picture of the protein molecule, and especially of the relation between the fibrous and the non-fibrous proteins, all such ventures were necessarily along empirical lines. The difference now is that what industry there was has been re-born as an inseparable part of protein science, with all the potentialities for advancement that this profoundest of molecular studies has to offer. It is in fact a logical prediction from the X-ray interpretation of protein denaturation that it should be possible to make fibrous from non-fibrous proteins; we can see now both what has to be done and the reason for it.

Since the beginning of the century, chemists have been increasingly convinced that all proteins are polypeptide chain systems, alone or in combination with various prosthetic groups; but there seemed to be a distinction between the fibrous and non-fibrous kinds in that the molecules of the latter are massive, rounded bodies that often aggregate to build orthodox, visible crystals; hence the name 'corpuscular' proteins. With the growth of the concept of fibres as 'molecular yarns' constructed from long chain-molecules, a concept to which many techniques have contributed but which first became 'real' under the methods of X-ray analysis, there ceased to be any formal difficulty with regard to the protein fibres, as was demonstrated by Meyer and Mark when, in 1928, they interpreted the diffraction pattern given by natural silk (fibroin¹); but the problem of the arrangement inside the corpuscular proteins remained, for sometimes the X-ray photographs showed sharp reflexions—characteristic to be sure of regular crystal lattices but not to be carried much beyond that on account of the large number of atomic parameters involved—but more often they showed simply two diffuse rings of spacing about 9½ Å. and 4½ Å., respectively. The first requirement was to explain these two rings, and this was done² on the basis of the X-ray data given by the elastic fibrous protein, keratin. Keratin did not fit in with the idea of extended polypeptide chains that had been found to suffice for fibroin; only the stretched form (β-keratin) could be interpreted on such a view, but the normal, unstretched form (α-keratin) demanded the postulate of a regularly folded configuration besides. The reversible intramolecular transformation between α- and β-keratin, corresponding to the transition between two distinct types of diffraction pattern, was recognized as providing the explanation of the well-known long-range elasticity of mammalian hairs and other keratinous tissues³.

Among other things, then, the X-ray study of keratin brought out the two main points from which in due course the theory of artificial protein fibres followed naturally. The α-form revealed for the first time the existence of polypeptide chains that are normally in a folded state, while the β-form gave the average dimensions per amino-acid residue (and therewith an estimate of the order of density of proteins and the mass per unit area of protein monolayers^{2,4}), and so bridged the gap to analytical chemistry and laid the foundations of a structural

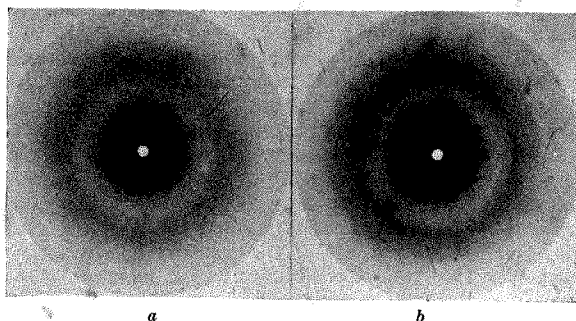


Fig. 1. X-RAY POWDER PHOTOGRAPHS OF (a) DRIED EGG WHITE, AND (b) DRIED BOILED EGG WHITE.

stoichiometry⁵. Thus was evolved the concept of the 'polypeptide grid', and the two rings so common in protein diffraction patterns were identified as arising from the two principal modes of linkage between neighbouring polypeptide chains, namely, that between the side-chains and that between the backbones². The corresponding spacings are now always referred to as the 'side-chain' and 'backbone' spacings.

The next advance came from an X-ray comparison of a number of protein preparations before and after wetting⁶. It was found that not only did the inner ring show the greater spacing variation from protein to protein, but also it generally showed a spacing increase on wetting. Both these properties would be expected if, as had been inferred from keratin, the reflexion represented the lateral separation of the main chains in the direction of the side-chains, and the evidence was in fact accepted as establishing the inference.

In the same investigation, among the preparations examined were egg and serum albumins that had been denatured (and coagulated) by heat. The obvious change brought about by this treatment was seen to be a marked sharpening of the backbone reflexion, and, less obvious, the appearance of at least one other outer ring of spacing about 3.6 Å. (see Figs. 1a and 1b). In short, it became clear—that the denaturation and aggregation of a corpuscular protein leads ultimately to a diffraction pattern like that given by disoriented β -keratin. When keratin is stretched from the α - to the β -form, the side-chain reflexion remains and a strong backbone reflexion arises by the process of flattening the polypeptide grids—pulling out the folds, that is, that lie in planes transverse to the side-chains. This is a mechanical operation, but it appeared now that a similar sort of change could be brought about in the structure of the corpuscular proteins by thermal agitation, for example. (Later, it was shown⁷ that the muscle protein, myosin, belongs to the same molecular family as keratin, and myosin can give either an oriented β -photograph by stretching or a disoriented β -photograph by heating.) In some way, therefore, the arrangement inside the corpuscular proteins was a generalization of the α -keratin idea; the situation was like α -keratin only more so. The polypeptide chains were there, but presumably they were folded and grouped in specific configurations from which in most cases they could be liberated fairly easily to produce a variety of non-specific configurations. Subsequent aggregation (at least as regards the more organized regions that are responsible for the regular diffraction pattern) in-

volved a building of 'crystallites'—sometimes more perfect, sometimes less perfect, but at any rate of the type of the aggregates of polypeptide grids that constitute the crystallites of β -keratin. (Denaturation of a corpuscular protein as here described is the thoroughgoing irreversible phenomenon as it is usually understood in Great Britain. Reversible loss of solubility and specificity is sometimes described as 'reversible denaturation', but such changes are conceivable without disorganization of the molecule as a whole. Sometimes, too, no clear distinction is recognized between denaturation and the aggregation of proteins that are already in an extended configuration⁸. Myosin 'denatured' by simple drying is still in the folded α -form, but there is disorganization of the folds if it is heated.)

It followed at once from this line of argument that if, after unfolding the polypeptide chains, they could be drawn parallel, or approximately parallel, then artificial fibres would result; and the test would be the production of an oriented β -photograph. Decisive orientation effects were first obtained with denatured preparations of the seed globulins, edestin (from hemp seed) and excelsin (from Brazil nuts), and also with 'poached' egg white⁹; while the first actual fibres were spun from strong urea solutions⁹. When edestin, for example, is dissolved in strong aqueous urea, the solution in time becomes very viscous, and elastic fibres may be produced either by drawing out the viscous mass or by squirting it through a capillary tube into water or dilute salt solution. (This sort of observation is not new, but it seems that X-rays first clearly exposed the reason for the rise in viscosity—the unfolding of round molecules to give polypeptide chains in extended configurations.) In general, though, such fibres have to be stretched farther in order to reveal definite orientation effects in the X-ray photographs. As a matter of interest, some of the early diffraction patterns are reproduced in Fig. 2. They illustrate the first demonstration by X-rays of the transformation of an originally crystalline protein into an elastic fibrous structure.

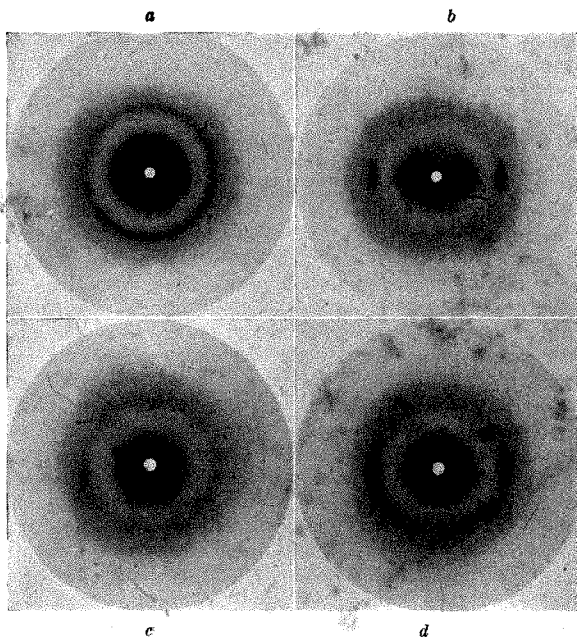


Fig. 2. (a) DISORIENTED β -KERATIN; (b) ORIENTED β -KERATIN; (c) DISORIENTED DENATURED EDESTIN; (d) ORIENTED (STRETCHED) DENATURED EDESTIN.



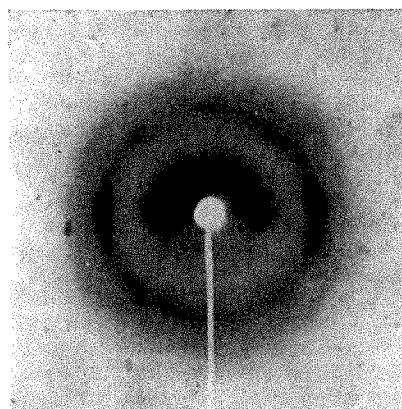
Fig. 3. ARDIL FIBRES.

Experiments on continuous fibre production from urea solutions were then conducted in Prof. A. C. Chibnall's laboratory at the Imperial College of Science and Technology, London; but later, though considerable further advances were made, it was felt better to return to the more fundamental side of protein research. Thereafter, as indicated above, the production of 'Ardil' (see Fig. 3) and its development to commercial satisfaction was the work of chemists of Imperial Chemical Industries, Ltd.¹⁰ 'Ardil' is produced from the peanut globulin, arachin, and the original urea process has now been replaced by extraction and 'maturing' with dilute alkali; also, striking new after-treatments have been evolved for improving the tensile properties of the fibres and their resistance to dyeing and finishing processes. Actually, the present stage of development was reached by the beginning of the War, but since then further work has been held up.

'Ardil' is a cream-coloured, crimped, elastic fibre that is soft and warm: it is a kind of artificial wool without surface scales. It greatly enhances the felting of wool, however, and dyes like wool, but it is not attacked by moths. Its elasticity arises from the circumstance that the unfolding of the original corpuscular molecules is imperfect, vestigial folds remaining that are an irregular counterpart of the regular α -folds to which the elasticity of keratin is due. As now produced, 'Ardil' shows no orientation in its diffraction pattern, but an oriented β -pattern begins to appear on stretching. Fabrics have been made purely of 'Ardil', but its best use is likely to be in combination with wool and other fibres. A by-product of its manufacture is, of course, arachis oil, of which peanuts contain 48-50 per cent; furthermore, after the oil and protein have been extracted, the residue can be used for cattle food.

During the last few years a number of important papers have been published in America on the preparation of artificial protein fibres with the aid of detergents¹¹. Products such as 'Nacconol NRSF' (which is essentially dodecyl benzene sodium sulphonate) are found to act as excellent unfolding agents for the corpuscular proteins, and with the technique described it is possible to make fibres much stronger than anything reported previously. Using egg albumin, for example, the complex formed by mixing equal portions of 3 per cent solutions of re-crystallized egg albumin and detergent is first precipitated with saturated magnesium sulphate, the resulting 'dough' is drawn out into fibres, which are washed with water and extracted with 60:40 acetone-water solution, and then finally the fibres are stretched by about 400 per cent in live steam. Before the stretching in steam, the orientation in the X-ray diffraction

pattern is of the 'crossed' type first observed with stretched films of poached egg white⁸, that was interpreted as corresponding to chain-bundles broader than they are long; but after the stretching it is as in β -keratin with the chain-bundles lying along the direction of stretching. (The effect illustrated in Palmer and Galvin's paper¹² is slight and was at first thought not to be there; but it is now agreed that before stretching in steam there is no real discrepancy with the 'poached egg effect'. Private communication.) The oriented β -pattern given by these stretched egg albumin fibres is very good indeed: it is shown in Fig. 4, which is a reproduction of a photograph kindly sent me by Dr. Palmer. Egg albumin is one of the most typical and most studied of all the crystalline corpuscular proteins, and here in the end it is made to yield one of the best β -fibre photographs! The wheel has now come full circle.

Fig. 4. FIBRE PATTERN (β -KERATIN TYPE) GIVEN BY EGG ALBUMIN FIBRES PREPARED BY LUNDGREN AND PHOTOGRAPHED BY PALMER AND GALVIN.

Lundgren and O'Connell report that artificial fibres from egg albumin (and from chicken-feather keratin, which also responds to the technique just described) have been prepared with breaking strengths of more than 70×10^3 lb. per sq. in.: to appreciate what this means, it may be noted that in the same table they quote 72-100 for nylon, 46-74 for natural silk, and 17-25 for wool. Incidentally, lest it should seem somewhat indecent these days to talk about using egg white for making fibres, it should be added that the same authors point out that there are available annually in the United States more than 26,000,000 lb. of inedible technical egg white (much of which goes to waste) and more than 170,000,000 lb. of chicken feathers.

¹ Meyer, K. H., and Mark, H., *Ber.*, **61**, 1932 (1928).

² Astbury, W. T., *Trans. Faraday Soc.*, **29**, 193, 217 (1933).

³ For references see, for example, Astbury, W. T., *Nature*, **137**, 803 (1936).

⁴ See also Astbury, W. T., Bell, F. O., Gorter, E., and van Ormondt, J., *Nature*, **142**, 33 (1938).

⁵ Astbury, W. T., "Advances in Enzymology", **3**, 63 (1943).

⁶ Astbury, W. T., and Lomax, R., *J. Chem. Soc.*, 846 (1935).

⁷ Astbury, W. T., and Dickinson, S., *Nature*, **135**, 95 (1935); *Proc. Roy. Soc., B*, **129**, 307 (1940).

⁸ See, for example, Coleman, D., and Howitt, F. O., *Nature*, **155**, 78 (1945).

⁹ Astbury, W. T., Dickinson, S., and Bailey, K., *Biochem. J.*, **29**, 2351 (1935).

¹⁰ Traill, D., *Chem. and Ind.*, Feb. 24, 1945, p. 58.

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X-RAY CRYSTALLOGRAPHIC MEASUREMENTS ON A SINGLE CRYSTAL OF A TOBACCO NECROSIS VIRUS DERIVATIVE

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AND

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IN August 1944, N. W. Pirie, of Rothamsted, sent us a few large crystals of a tobacco necrosis virus derivative (Rothamsted strain)¹ on which we have been able to make some X-ray measurements. Before we could complete the investigation the preparation unfortunately deteriorated, but the crystals are in themselves so remarkable that it seems worth while to give a preliminary account of their characteristics. They are described as of a crystalline derivative rather than as crystals of the virus itself, since by the time the preparation had crystallized it had lost its infectivity. It shows, however, the same serological and ultracentrifugal behaviour as the active material and so probably does not differ greatly from this². The molecular weight indicated by the sedimentation constant is at least 1,850,000, and this order of magnitude is confirmed by our present measurements.

The crystals were of quite unusual size, 1–5 mm. across, and appeared to be of two forms, thick triclinic prisms and thin hexagonal or pseudo-hexagonal plates. They had been grown for more than a year from aqueous solution, and when received were adhering to the walls of the tube covered with a film of moisture. The thickest crystal of all, which was of the first kind and measured approximately 2 mm. × 1 mm. × 0.5 mm., was washed into a drop of 1/10 saturated ammonium sulphate solution and drawn into a thin-walled Lindemann glass capillary which was then sealed off. In this tube it could be examined still covered with a film of liquid.

In form the crystal was a thick prism tending to be elongated along [111] and bounded by well-defined faces, probably {011}, {110} and {101}. In polarized

light it showed low birefringence with oblique extinction when viewed parallel to (100), and approximately straight extinction along [111] when viewed perpendicular to (100), which suggested monoclinic or pseudo-monoclinic symmetry. These measurements could not be made very accurately owing to the position of the crystal in the tube. But in essentials they are confirmed by the X-ray data, which show that the crystal is triclinic, with $a = 179 \text{ \AA}$., $b = 219 \text{ \AA}$., $c = 243 \text{ \AA}$., $\alpha = 87\frac{1}{2}^\circ$, $\beta = 97\frac{1}{2}^\circ$, $\gamma = 97\frac{1}{2}^\circ$ (reduced cell), space group $P1$; and that there is a marked approach to monoclinic symmetry, which is better illustrated by adopting the larger unit cell $a' = 179 \text{ \AA}$., $b' = 303 \text{ \AA}$., $c' = 346 \text{ \AA}$., $\alpha' = 96^\circ$, $\beta' = 101^\circ$, $\gamma' = 90^\circ$, space group $A1$. In the account which follows, the indices given refer to the pseudo-monoclinic cell.

In order to measure these very large cell dimensions, using copper $K\alpha$ radiation, five $2\frac{1}{2}^\circ$ oscillation

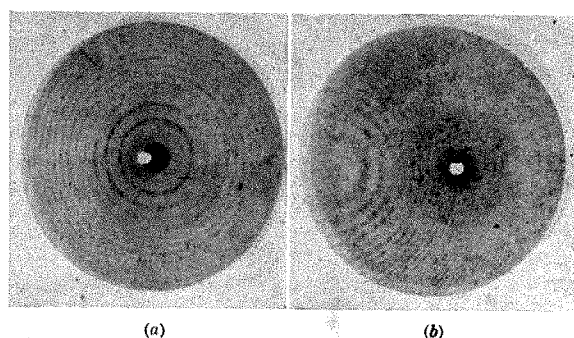


Fig. 2. TOBACCO NECROSIS VIRUS DERIVATIVE.

- (a) Crystal 'still'. X-ray beam nearly perpendicular to (h^*00). Reflexions from (h^*00). 12 hours exposure.
(b) Crystal 'still'. X-ray beam 60° from (h^*00). Reflexions from (h^*00), ($4h^*k^*0$), ($3h^*k^*0$). 10 hours exposure.

photographs were taken of the crystal rotated about the normal to (001), with a plate-to-crystal distance of 10.1 cm. (Fig. 1). The X-ray beam was defined by a lead glass capillary of bore 0.025 cm. kindly lent to us by Dr. W. T. Astbury. With this slit system there is some blurring of neighbouring hkl reflexions for which the index k varies only by 1, since the interval, $b = 303 \text{ \AA}$., is outside the theoretical limit of resolution; but since there are sharp reflexions with indices $0kl$ differing by various multiples of k , the lattice is defined unambiguously. Apart from this difficulty, the patterns of the X-ray reflexions on the oscillation photographs are exactly comparable with those found on simpler crystals, the only difference being one scale.

This difference of scale makes it possible, however, for us to estimate the unit cell dimensions in quite a different way on a new variety of X-ray photograph. The unit cell dimensions are so large that, even when the crystal is kept stationary, innumerable crystal planes are geometrically in a position to reflect monochromatic X-rays. Photographs obtained with the crystal 'still' accordingly show numbers of X-ray reflexions, and these, though individually unresolved, are characteristically arranged on the plate in series of concentric circles, or ellipses (Fig. 2). Their arrangement is most easily understood by referring the process of reflexion in the usual way to the interaction of the crystal reciprocal lattice with the sphere of reflexion^{3,4}. In reciprocal space the lattice points are crowded together so that many will be in contact with the sphere of reflexion in any position of the

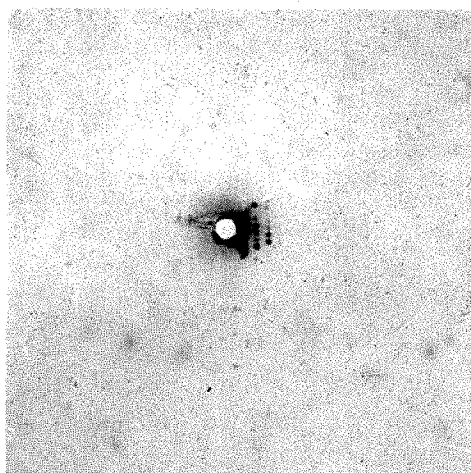


Fig. 1. TOBACCO NECROSIS VIRUS DERIVATIVE.

$2\frac{1}{2}^\circ$ oscillation photograph, crystal rotating about normal to (001), X-ray beam parallel to (100). 90 hours exposure.

crystal relative to the X-ray beam. The points are, however, grouped into reciprocal lattice planes, and these intersect the sphere of reflexion in circles, where the interval between two concentric circles depends on the spacing of the series of parallel reciprocal lattice planes and hence inversely on the crystal cell dimensions. The diagrams in Fig. 3 illustrate the process.

Since only reciprocal lattice planes with large spacings and in a position not far from normal to the

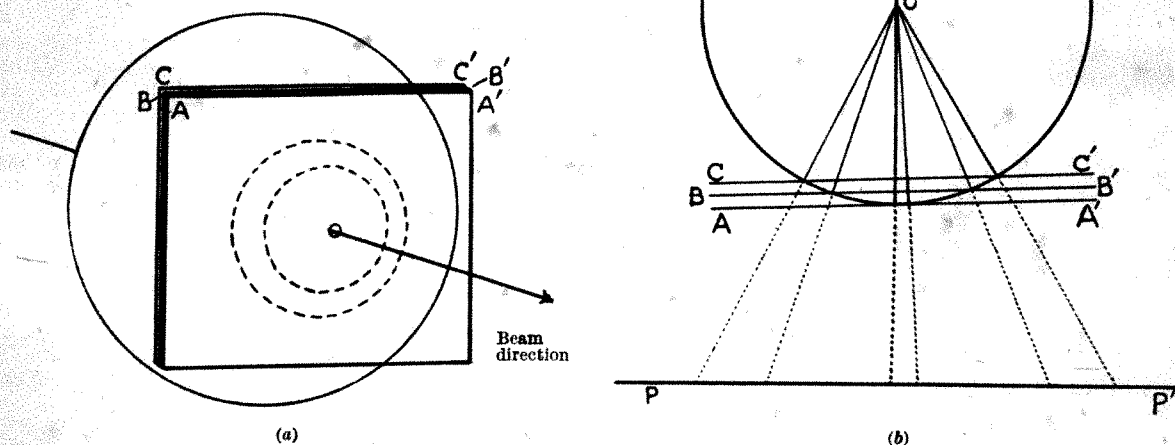


Fig. 3. INTERACTION OF RECIPROCAL LATTICE PLANES WITH THE SPHERE OF REFLEXION (a) IN PERSPECTIVE, (b) IN PROJECTION. AA', BB', CC', reciprocal lattice planes; O, centre of sphere of reflexion; PP', photographic plate.

beam direction can give well-defined circles or ellipses when projected on to the photographic plate, three or four 'still' photographs at intervals of 30° or so serve to define the lattice normal to any particular rotation axis. In the present case we first deduced two of the three reciprocal cell dimensions from a series of 'still' photographs which showed reflexions from the reciprocal lattice planes (h^*00) , $(0k^*0)$, (h^*k^*0) , $(h^*\bar{k}^*0)$, $(2h^*k^*0)$, $(3h^*k^*0)$, $(4h^*k^*0)$, (h^*2k^*0) and $(3h^*2k^*0)$, and afterwards took the oscillation photographs when we knew the degree of resolution we should need. With our apparatus a good 'still' photograph at a plate-to-crystal distance of 4 cm. could be obtained in twelve hours, while the best oscillation photograph took ninety hours. As these exposure times with our X-ray tubes were so long, we transferred the crystal, at the kind invitation of Sir Henry Dale, to the Davy Faraday Laboratory, at the Royal Institution, London, for photography with a more powerful tube. One trial photograph was taken in four hours, but at this stage an accident to the crystal prevented further work. In all, the crystal was exposed for approximately five hundred hours to X-radiation without apparent deterioration.

While the 'still' photographs provide good evidence on the cell dimensions, we have to turn to our very limited series of oscillation photographs for further details of the crystal structure. One striking feature of the X-ray photograph reproduced (Fig. 1) is the absence of a number of reflexions, $h0l$, where h is odd, which suggests that there is a pseudo-glide plane of symmetry present and that the arrangement of the molecules in the crystal approximates to that required by the space group Aa . In this event there must be four units in the face-centred unit cell or two in the primitive cell measured above. In the absence of measurements of crystal density and of water content, we can only give a rough estimate for this unit molecular weight based on measurements of

these quantities on other virus crystals. If we take the figures for the crystalline bushy stunt virus⁵, water content 55 per cent, density 1.286, the molecular weight of the tobacco necrosis virus derivative can be calculated as 1,600,000. But since the nucleic acid content of tobacco necrosis virus is higher than that of bushy stunt virus, it is probable that the density is greater, and this figure may therefore be regarded as a lower limit for its molecular weight. As such it compares well with the ultracentrifuge figure given above, 1,850,000, which is also a lower limit calculated⁶ for a spherical molecule with the observed sedimentation constant, 50×10^{-13} .¹ Actually the crystal structure suggests that the molecules do not differ in shape very markedly from spheres. On this view the estimated molecular dimensions vary from about 80 Å. as a minimum radius to a possible maximum of 100 Å. radius in one direction.

The presence of even a pseudo-glide plane of symmetry in the crystal structure of a molecule certainly containing asymmetric centres may appear at first sight odd. But this effect again must be due to the enormous size of the molecule. It has only been observed so far for reflexions with spacings greater than 25 Å., and the intensities of these can be sensitive to little more than the general shape and position of the molecules in the unit cell. With fresh material we hope to be able to extend our survey of the X-ray reflexions and to obtain a better idea of the actual dimensions of the virus molecule. That the required X-ray data can be got is proved by the 'still' photographs, which show X-ray reflexions from planes with spacings as small as 2.8 Å.

¹ Bawden, F. C., and Pirie, N. W., *Brit. J. Exp. Path.*, **23**, 314 (1942).

² Bawden, F. C., and Pirie, N. W., to be published shortly.

³ Ewald, P. P., *Z. Krist.*, **56**, 129 (1921).

⁴ Bernal, J. D., *Proc. Roy. Soc., A*, **113**, 117 (1926).

⁵ Bernal, J. D., and Fankuchen, I., *J. Gen. Physiol.*, **25**, 111 (1941).

⁶ Ogston, A. G., private communication.

OBITUARIES

Sir Thomas Lewis, F.R.S.

SIR THOMAS LEWIS died on March 17, at the age of sixty-three, when still in full mental vigour. He leaves behind him a long train of brilliant achievements; and the path through which he moved for the illumination of medical science by clinical research will not remain void, for in the last twenty years of his life he had devoted his chief thoughts to the firm establishment of a group of men who understood his aims and would maintain their impulse.

Lewis himself was as distinguished for his researches in pure physiology as for his clinical authority in the diagnosis and care of heart disease. Yet neither field taken alone could satisfy him. He desired intensely the progress of medical skill, for he had seen the abundance of clinical problems waiting for study by precise scientific thought. Knowledge would not come quickly enough and many clinical questions would remain untouched if they were left to pathologists or physiologists for an answer. So he strove for the recognition of clinical science as a separate member of the group of biological sciences, a member that would make use of any of its sister sciences and yet be sovereign within its own clinical jurisdiction.

As the Physiological Society has been founded to bring physiologists together in helpful debate and fellowship, so Lewis in 1930 founded the Medical Research Society and transferred to it his journal *Clinical Science* with the aim of giving to that band of scientific workers their own tourney ground. The success of such a movement to bring scientific ways of thought into the heart of clinical experience was the dearest of Lewis's hopes, and despite his untimely death it will not now fail.

Lewis came of pure Welsh lineage, perhaps the most distinguished man of science as yet given to the world by the Principality. His father had an important place there in mining, having been president of the Coal Owners' Association; but Lewis when quite a young boy had preferred medicine for the quaint reason that the family doctor had delighted him by being a skilful conjurer. It was the side delights, apparently inhering in medicine, rather than the straightforward work of a doctor that entranced him. His abilities were soon proved by scholarships and gold medals in progress through medical training at Cardiff and later in London. But all this time his mind was finding chief satisfaction in the laboratories of physiology, where he had begun research and published papers even before qualification. In London, through acquaintance with Starling, Cushny and Leonard Hill, all busy with problems of the circulation, he met James Mackenzie and discussed with him the nodal rhythm that the latter had proposed in explanation of the particular type of irregularity of the heart-beat which he had studied clinically by venous tracings. Einthoven in Holland had recently devised a delicate galvanometer which could be used for analysis of the heart's action in man. Lewis seized the vital chance, obtained the instrument, and with it quickly proved, in 1909, that the particular irregularity in man was due to auricular fibrillation. This mechanism had been earlier identified in animal experiments by Cushny; but the physiological discovery was waiting its application to analysis of disorders of the human heart. The application was

relatively easy and it was made at the same time by workers in Vienna. But Lewis's genius, now that fortune had granted him this opening to fruitful research, moved far and fast with it. He concentrated all his clinical experience upon analysis of the forms of irregular heart-beat, identifying each by its galvanometric curve and then studying separately the prognosis and treatment of each form. But more profound analysis of the character of each electrical curve of irregularity was needed, and to this end Lewis commenced a series of experiments on the dog's heart, delicate and difficult instrumental studies involving exact analysis of the time relations of the electric change at successive points, inner and outer, along the walls of the double-chambered ventricle. These measurements traced the path of the wave of contraction, and so gave the first analysis, in 1916, of the *PQRS* curve in the normal electrocardiogram. From this followed in 1920 a satisfactory account of the sites of origin in the human heart of the various forms of irregularity seen in disease.

Meantime Lewis had come to a clear decision as to what his life in medicine was to be. He desired research based continually on clinical experience. In 1910 the newly created Beit Fellowship had given him freedom for three years to follow this aim. Soon after that came the War and Lewis was attached to a special military hospital for study of the soldier's heart. In 1916 the Medical Research Council offered him a permanent position on its external staff, and Lewis gladly accepted this escape from the road that would have rapidly led to a great consulting practice in heart disease but away from intense and progressive research. At the end of the War he returned to the staff of University College Hospital and the enjoyment of a laboratory adequately staffed by the Medical Research Council. But he had shown during the war period that important discoveries could be made by use of the simplest apparatus, such as a sphygmomanometer, provided it were guided by subtle thinking; and his demonstration in 1916 of the contractility of the capillaries by adrenalin led him to the exploration later of entirely new fields of his own. The results were summarized in 1927 in his book on the "Bloodvessels of the Human Skin", in which he analysed their nervous control and particularly their inflammatory reaction to a chemical substance, akin to histamine, found by him to be normally released upon injury to skin cells. This idea of an autochthonous chemical irritant of nerves, now running parallel with the discoveries of physiology in respect of cholinergic nerves, was later extended by Lewis to include some forms of pain, for example that of angina pectoris; and from that he was moving to a hopeful investigation of deep visceral pain, a matter of intense importance to clinicians, when in 1939 war again came and ended the work.

Lewis had been elected fellow of the Royal Society in 1918, at the early age of thirty-six, and in 1941 he received its Copley Medal, the highest recognition that British science can give for fundamental discovery. Not since Lord Lister, in 1902, had this award been made to an active clinician. His world-wide reputation naturally brought him the honorary membership of many learned societies and the degrees of many universities at home and abroad. In practical medicine the teaching of two books upon heart diseases, which he wrote deliberately for medical practitioners—and they were translated into several foreign languages—had a transforming influence so

complete that it is now almost forgotten that the change was largely due to his researches. Otherwise he refused to spare time for routine discussions at medical societies, for he had no wish to stay fixed on a summit as an acknowledged heart specialist. Independence had been given to him by that intensely important move of the Medical Research Council when it led the way in creating whole-time posts for clinical research, and so he could go wherever his genius beckoned. With his amazingly clear and penetrating intellect he was the mainstay of scientific progress in all departments of his medical school at University College Hospital. Young or old, but especially the former, found him eager and ready to help them. He had the devotion of a zealot to his cause, but a devotion that had no self-seeking or personal conceit to mar it. And work was not all. There was time for pleasures of the countryside, a garden, trout fishing, and especially watching the wild birds that he knew so intimately and photographed with such artistry. Friendships, not readily accepted but staunchly held, also played their part, but chief of all was his happiness in married life.

T. R. ELLIOTT

Mr. W. E. Nicholson

WILLIAM EDWARD NICHOLSON, who died at Mullion, Cornwall, on February 13, was, after his life-long friend, H. N. Dixon, the best known authority in Great Britain on the taxonomy of the bryophytes. He was interested particularly in the European mosses and in European and exotic hepatics.

By profession a solicitor, Nicholson was born in 1866 at Lewes, Sussex, where almost the whole of his life was spent. He was educated at Marlborough until ill-health compelled him to leave at an early age. From boyhood he was deeply interested in natural history, and until middle life as much in entomology as in botany. Towards the end of the last century, Nicholson began the study of the mosses and liverworts, receiving help and encourage-

ment from William Mitten, the veteran Sussex bryologist and the greatest authority on the exotic mosses of his day. Later he came into contact with H. N. Dixon, and the two soon gained an international reputation for a number of remarkable additions to the European flora made on journeys ranging from southern Portugal to Tornean Lapland.

Though without a scientific training, Nicholson had a keenly critical mind and abnormally acute powers of observation, which were strikingly shown by the extraordinarily large number of species he was able to discover in his native Sussex, including many of the minute and elusive species of *Cephaezella*.

Nicholson wrote a number of short papers on British and foreign bryophytes, among which his papers on the mosses and liverworts of Sussex were particularly noteworthy. In his later years most of his time was devoted to exotic hepatics, and his most important work in this field was his account of the Chinese collections of the Freiherr von Handel-Mazzetti published in *Symbolae Sinicae* in 1930.

Besides botany, Nicholson's chief interest was in archaeology, and he was for fourteen years secretary of the Sussex Archaeological Society.

P. W. RICHARDS.

WE regret to announce the following deaths

Dr Denis Coffey, formerly president of University College, Dublin, and vice-chancellor of the National University of Ireland, on April 3, aged seventy-nine.

Sir Ambrose Fleming, F.R.S., on April 18, aged eighty-five.

Mr A. R. Hinks, F.R.S., C.B.E., secretary of the Royal Geographical Society since 1915, on April 14, aged seventy-one.

Dr Bohuslav Vrbenský, a Czechoslovak medical man, who held office as Minister of Health and Minister of Public Works in several Governments, and in particular was instrumental in securing improved working conditions for Czechoslovak miners, on November 25, 1944, aged sixty-two.

NEWS and VIEWS

Pure Mathematics at Cambridge :

Prof L. J. Mordell, F.R.S.

THE election of Prof L. J. Mordell as successor to Prof G. H. Hardy in the Sadleirian chair of pure mathematics at Cambridge will not have come as a surprise to those who are aware of his international reputation as a leading British mathematician. His main interest has always been in the theory of numbers, and to this subject he has made perhaps as great an original contribution as any mathematician in Britain, past or present. Among outstanding achievements one may mention (1) the proof that all rational solutions of a cubic equation $f(x,y) = 0$ can be derived by a well-known rational process from a finite number of them (Mordell's finite basis theorem), (2) his work on the representation of a number as a sum of squares, which has its root in Mordell's mastery of the theory of modular functions, (3) his work, mostly in recent years, on the geometry of numbers, where he has opened up new avenues of investigation. Characteristic of Mordell's work is

the significance of the problems he has formulated and attacked. The advances he has made, apart from their intrinsic importance, have often been the starting point for work by other distinguished mathematicians.

Mordell went from Philadelphia to St John's College, Cambridge, in 1907 with a senior scholarship in mathematics awarded on the scholarship examination of December 1906. He was third wrangler in the 1909 Tripos. After being lecturer at Birkbeck College, London, he went to Manchester, where he has been Fielden professor of pure mathematics since 1923. In 1941 he was awarded the De Morgan Medal of the London Mathematical Society (of which he is now president). From about 1933 onwards, Mordell gathered round himself at Manchester a group of mathematicians from all over the world, whose interests were mainly in number-theory. The success of the 'Manchester school' in original work owed everything to the fertility of Mordell's suggestions, to the keen interest and zest with which he followed their discoveries (even the least significant),

and to the constant inspiration of his own work. It cannot be an easy task to succeed Prof Hardy, but we can feel confident that the high tradition associated with the Sadleirian chair will be fully maintained.

Prof. E. R. Gilliland

PROF EDWIN RICHARD GILLILAND, professor of chemical engineering at the Massachusetts Institute of Technology, has been awarded the Leo Hendrick Baekeland Award of the North Jersey Section of the American Chemical Society, "for outstanding achievement in the fields of heat transmission, diffusion, distillation, and high-pressure synthetic chemistry". The award, consisting of 1,000 dollars in cash and a gold medal, is to be given biennially to an American chemist less than forty years of age in recognition of accomplishments in pure or industrial chemistry, and was founded to commemorate the technical and industrial work of the late Dr Baekeland. Prof Gilliland, who is thirty-six, is at present working in the Office of Scientific Research and Development, Washington, D.C. He is known as an advocate of the maintenance of a post-war synthetic rubber industry in the United States as essential to the national interest. Prof Gilliland joined the teaching staff at the Massachusetts Institute of Technology as instructor in 1934, and in 1944 was made a full professor.

Prestwich Prize of the Geological Society of France

PROF W. B. R. KING, Woodwardian professor of geology in the University of Cambridge, has been awarded the Prestwich Prize of the Geological Society of France. This prize is the only one which the Society can give to a non-member, and has been given to Prof. King in recognition of his distinguished researches and also for his services to France in "la géologie militaire" during the War of 1914-18 and 1939-45 as geological adviser to the British Army.

Medal of the Liverpool Geological Society

THE Liverpool Geological Society has awarded its medal to Dr Douglas A. Allan, director of the Royal Scottish Museum, Edinburgh, in recognition of his original geological work, mainly on problems connected with the structure and petrology of the Highland Border of Scotland and Angus. The award is also an acknowledgment of the great services rendered to the Society by Dr Allan during the fifteen years he spent in Liverpool as director of the City museums. He has edited its *Proceedings* for fourteen years, and by his lectures and writings has done much to develop and extend an interest in geological science which has been of great benefit to the Society.

Antonín Bělohoubek (1845-1910)

THE centenary of the birth of the elder of the brothers Bělohoubek falls on April 28. Overcoming initial disabilities, both these Czechs became distinguished chemists and influenced the progress of science in Central Europe. Born at Jeřice in Bohemia, Antonín Bělohoubek was the pupil of Balling and began his scientific career as a demonstrator at the Prague Technical College in 1865. He was appointed *docent* in 1871 and professor of applied chemistry and the technology of fermentation in 1880. In this field he was a pioneer in utilizing the microscope to study

biochemical problems. His published researches, mostly conducted during the 'seventies and 'eighties of last century, relate mainly to contemporary analytical procedure. From chemical and bacteriological investigations of thermal and river waters he was led to make geological surveys, and to take an interest in water purification and the disposal of industrial fluids.

Antonín Bělohoubek came before the general public in Central Europe in 1887 during the controversy concerning the genuineness of certain old Czech manuscripts found at Kraluv Dvůr in 1818, for he was the expert called in to make the microscopic and chemical examination. He was also the first to show that chloroform could not be obtained from methyl alcohol by the use of bleaching powder. Later, he became director of the chemical section of the Austro-Hungarian Patent Office in Vienna, but eventually returned to Prague, where he died in 1910. His brother, Augustus Bělohoubek (1847-1908), became lecturer in pharmacy at the Prague Technical College and is best known for his comprehensive survey of the solubility of organic compounds. He also wrote a treatise on drugs that had a considerable vogue towards the end of last century.

Exchange of Diagrams and Data between Radiotherapy Centres

MEDICAL physics is rapidly expanding into an important and well-defined branch of applied physics. At the present stage of development much information is becoming available for everyday use in hospitals, but the information is scattered through a number of journals and sometimes difficult of access. Of particular importance is the distribution of radiation throughout the soft tissues of a patient during irradiation with high-voltage X-rays or gamma rays. This distribution of radiation is a complex function of the physical conditions, and recently Prof W. V. Mayneord published a set of X-ray isodose curves giving data of direct practical application. At a meeting of the Hospital Physicists' Association it was suggested that this idea might be applied to telerradium isodose curves, and to other data. It was thought that often graphs and diagrams which appear in the literature were too small to be useful, and that many workers would like to have full-size copies of the originals. In addition, various institutions accumulate diagrams, nomograms, and data for their own use, which would be very useful to others if an interchange of copies could be arranged.

The Hospital Physicists' Association therefore appointed a sub-committee with Dr John Read, of the London Hospital, Whitechapel Road, London, E.1, as secretary. This sub-committee has collected lists of diagrams, data, etc., which institutions are willing to lend for reproduction, and prepared a catalogue of copies which can be supplied. The catalogue includes books not easily obtainable, a short loan of which can be arranged. Some idea of the contents of the catalogue may be gathered from the fact that it covers isodose curves of a large variety of size of field and other conditions, distributions of energy in X-ray spectra, isodose curves around radium tubes and needles of various sizes, and the distribution and amounts of radium to be used to obtain uniform fields in various conditions, photo-electric absorption coefficients in various elements, energy absorption in water and other biological media, and tables of electronic functions.

Chemical Society : Annual General Meeting

THE annual general meeting of the Chemical Society was held in London on April 19, the president, Prof V N Haworth, in the chair. During the business portion of the meeting, Prof Haworth referred to a letter he had received from N Derzhavin, conveying greetings from men of science in Latvia and directing attention to the crimes committed by the German invaders on the Latvian people, and his proposed reply was read and endorsed. Prof Haworth also agreed to convey the deep sympathy of the Council to the American Chemical Society on the loss of their great national leader, and also greetings to the Belgian, French and Russian Chemical Societies, expressing joy at the liberation of their countries from the foreign invader. In presenting the Report of Council for 1944, reference was made to the retirement of the general secretary and to the following resolution passed by the Council: "The Council has received with profound regret the news of the coming retirement of Mr S E Carr from the office of General Secretary. It desires to place on record its deep feeling of gratitude for the great services he has rendered to the Society over a period of forty-two years." It was declared that Prof H V A Briscoe had been elected honorary secretary, and the following as new members of Council as *Vice-Presidents*, Prof. A J Allmand, Prof J W Cook and Prof M Heilbron, as *Elected Ordinary Members of Council*, Prof Wilson Baker, Mr R P Bell, Prof L T S Britton, Dr D H Hey, Dr B Jones, Dr J. W Le Fèvre, Prof J. M Robertson, Dr F S Spring, Dr M Stacey and Prof A R Todd.

Philosophical Magazine

THE *Philosophical Magazine* is now within two years of celebrating the hundred and fiftieth anniversary of its first publication. The outlook of physical science has changed in the intervening years almost beyond recognition, and it has seemed desirable to the proprietors of the journal to alter the title, while retaining the familiar name of the *Philosophical Magazine*, in such a way as to indicate more clearly the scope of the journal. The old read "The London, Edinburgh and Dublin Philosophical Magazine and Journal of Science, being a continuation of Tulloch's 'Philosophical Magazine', Nicholson's 'Journal' and Thomson's 'Annals of Philosophy'." The new title, which appears for the first time in the current number, "The Philosophical Magazine, a Journal of Theoretical, Experimental and Applied Physics." The journal has had a long and distinguished career and has numbered among its editors some of the most eminent physicists of the nineteenth and twentieth centuries. Its pages have appeared many papers of fundamental importance, during the present century, for example, classic papers by J J Thomson, Rutherford, Bohr and Rutherford have been published in the journal which, despite a marked increase in the number and publications of the learned societies, still holds an honoured place among its contemporaries.

New Theory of the Origin of the Planets

A BRIEF reference is made in the *Observatory* of December to a new theory of the origin of the planets, which, according to the *Moscow News*, was communicated to the Academy of Sciences of the U S S R on June 1, by O J Schmidt, of Arctic fame—a celebrated mathematician and geophysicist. The theory is based

on the rotation of the galaxy, as a result of which two stars sometimes approach so closely that the capture of one by the other occurs, a stable system—a binary—being formed. A star—our sun, for example—passing through one of the meteorite clouds in the Milky Way captures part of the meteorites, and this capture leads to the formation of planets revolving round the sun. It is stated that Schmidt's theory leads to mathematical formulæ which agree with astronomical observation, but it is necessary to suspend judgment until the original paper is available.

Isovol Map of the South Wales Coalfield

AN important contribution to our knowledge of the coals of South Wales has been issued by the Fuel Research Organisation of the Department of Scientific and Industrial Research in the form of an isovol map (1s 3d) and an explanatory booklet (6d.) which describes how the map was compiled, its implications and uses (*Fuel Research Survey Paper No 56*). Both are published by H M Stationery Office, 1944. The 'isovols' plotted on the map are lines of equal volatile content and show graphically the results of the determinations of volatile matter in samples of all the seams so far examined. Further editions will be issued as the survey proceeds. Since volatile matter constitutes, especially in South Wales, a valuable index of the physical and chemical nature of the coal, the map summarizes much of the work of the coal survey in this area up to date, and shows, simply and accurately, where each of the widely differing types of coal occurs. The booklet describes methods of analysis and contains a useful discussion of the relationships between volatile percentages, carbon percentages, calorific value and caking properties—all important factors in assessing the value of the coals.

British Simuliidæ

THE Simuliidæ or 'black flies' are represented in Britain by nineteen species. Their larvæ and pupæ are always aquatic, and the adult females are active blood-suckers. In the British Isles the attacks of the adult insects on man are seldom more than a nuisance, but to horses and cattle they cause much irritation and the animals are often compelled to seek shelter at times when they should be feeding or resting. In such circumstances they will not thrive or put on weight as they should do in normal circumstances. A useful guide to these insects entitled "The British Simuliidæ" by Dr John Smart has recently come to hand. It is published by the Freshwater Biological Association, Wray Castle, Ambleside, from which it can be purchased, price 2s 6d. The pamphlet is well printed and admirably illustrated with numerous original figures. By its aid it should be possible to identify not only the adults but also the larvæ and pupæ of these insects.

University Electoral Registers

IN view of the impending general election in Britain, Mr D Veale, registration officer, University of Oxford, writing on behalf of all university registration officers, urges every voter for a university constituency who has changed his address since registering as an elector and who has not notified the electoral registration officer of his university of such change, to do so as soon as possible. Prompt response to this appeal would not only save many last-minute applications

for voting papers but would also help to ensure that those who have a right to receive voting papers receive them in time to record their votes

The Night Sky in May

New moon occurs on May 11d 20h 21m UT, and full moon on May 27d 01h 49m. The following conjunctions with the moon take place: May 8d 16h, Mars 4° N, May 9d 11h, Venus 7° N, May 9d 23h, Mercury 2° N, May 15d 03h, Saturn 0.2° S, May 20d 11h, Jupiter 4° S. Occultations of stars brighter than magnitude 6 are as follows: May 15d 20h 23m, δ Gem. (*D*), May 15d. 20h 56m, δ Gem. (*R*), May 16d. 21h 27m., 49 B. Canc. (*D*). The times refer to the latitude of Greenwich and *D* and *R* refer to disappearance and re-appearance respectively. Mercury rises about half an hour before sunrise throughout the month and will not be an easy object to observe. It reaches its greatest westerly elongation on May 11. Venus is conspicuous in the eastern sky, rising an hour before the sun on May 1 and about an hour and a quarter before the sun on May 31. The planet is stationary on May 4 and May 24. Jupiter can be seen throughout the early morning hours, setting at 3h 11m, 2h 15m and 1h 10m at the beginning, middle and end of the month, respectively. Saturn is becoming more difficult to observe as it sets at midnight on May 1 and at 22h 26m on May 31. The η Aquarid meteor shower is due in the early part of May. The meteors appear in the early morning hours but moonlight will interfere with observations.

Comments on Chromosome Structure

In *Nature* of April 21, p. 471, an article by Dr I. Manton under this title was published. The accompanying illustration, however, was very unsatisfactory, due apparently to defects in the block. Accordingly a new block was prepared and the illustration is repeated below, with the explanatory legend

Announcements

SIR JOHN ORR, professor of agriculture in the University of Aberdeen, has been elected a member of Parliament for the Scottish universities, taking the place of Mr G. A. Morrison, who has resigned.

THE following appointments have been made in the University of London:

Dr Edmund Giffen, since 1940 director of research at the Institution of Automobile Engineers, to the University chair of civil and mechanical engineering, tenable at Queen Mary College, from October 1, 1945.

Prof. Harold Davenport, professor of mathematics at University College, Bangor, to the Astor chair of mathematics at University College, from October 1, 1945.

DR. NORMAN WRIGHT, director of the Hanna Dairy Research Institute, who has been undertaking a survey of the livestock in the Middle East territories during the past five months, has interrupted his tour in order to make a brief visit to Ceylon, where he is to advise the Ceylon Government on the future development of the cattle and dairy industries of the island. Dr Wright will shortly resume his Middle East tour. He is expected back in Great Britain by the end of June.

THE International Commission on Zoological Nomenclature announces the election of Dr James I. Peters, curator of birds, Museum of Comparative Zoology at Harvard College (assistant secretary to the Commission), to be vice-president of the Commission in succession to the late Dr C. W. Stiles, Smithsonian Institution, Washington.

THE following appointments have recently been made in the Colonial Services: J. E. Cobby, to be assistant conservator of forests, Kenya; K. G. N. Willcocks, to be government chemist, Gold Coast; H. Hirst, acting director of agriculture, Malta; to be assistant director of agriculture, Cyprus.

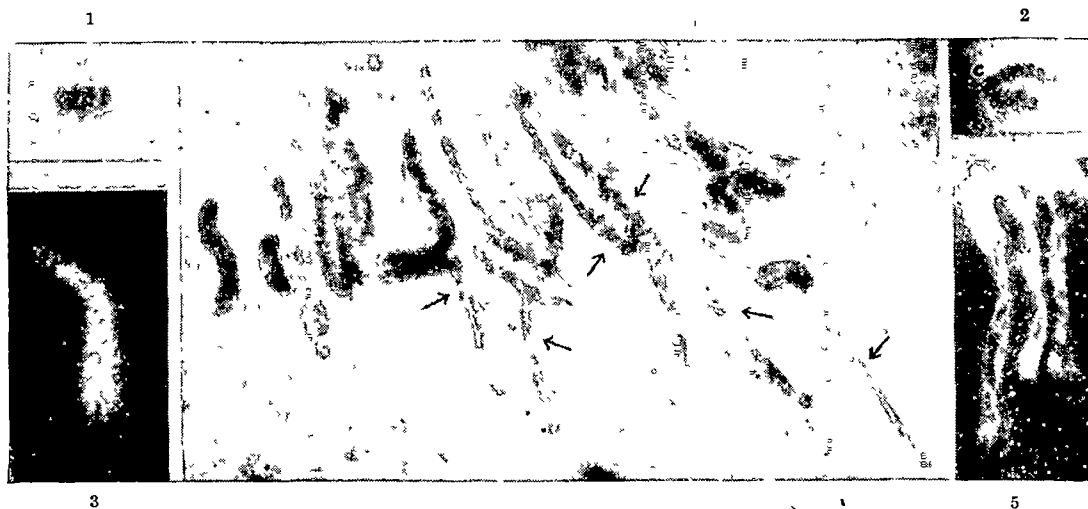


Fig. 1 Unpaired chromosome of *Osmunda* at the first meiotic division after ammonia treatment for spiral structure. Acetocarmine preparation photographed in clove oil by visual light ($\times 2000$).

Fig. 2 Split chromosome at the second meiotic division in *Osmunda* after ammonia treatment for spiral structure, the two chromatids are attached only at the centromere (*c*). Acetocarmine preparation, ultra-violet photograph ($\times 2000$).

Fig. 3 Split chromosome at metaphase of the third spore division in *Osmunda* showing spiral structure without special treatment. Acetocarmine preparation, ultra-violet photograph ($\times 4000$) negative print (the positive of this and others in Manton and Smiles, 1943²).

Fig. 4 Anaphase of the first spore division in *Osmunda* fixed 30 hours after irradiation of the uninucleate spore with X-rays at 2,500 r showing fractures, fusions and abnormally clear spiral structure. Acetocarmine preparation, visual light photograph ($\times 1000$).

Fig. 5 Anaphase of the third spore division in *Todea* after ammonia treatment, showing lateral separation of component strands. Acetocarmine preparation, ultra-violet photograph ($\times 4000$), negative print (the positive of this and other chromosomes in Manton, 1945³).

LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications.

Kinematical Relativity and the Nebular Red-Shift

PROF J. B. S. HALDANE's far-reaching deductions¹ from Prof. E. A. Milne's "kinematical relativity" excite our admiration, but they must also excite in many a feeling of apprehension lest, in our eagerness to build, we ignore defects in the foundations. Before extrapolating so extensively as Prof. Haldane has done, we should surely ascertain that kinematical relativity can explain what we do know. I have already, in *Nature* and elsewhere, objected to its essentially unscientific character, the purpose of his letter is to point out what seems to me its failure to explain the one fact we have relating to the distant past, namely, the nebular red-shift.

In Prof. Milne's recent letter on "The Ageing of Light"² the "usual Doppler effect" is assumed without comment. That letter, of course, is concerned not with the nebular red-shift, which is shown by light originating in the nebulae, but with the behaviour of hypothetical light originating in our galaxy and supposed to have been reflected to and from the same nebula from the beginning of time until now. Its validity also, however, depends on a satisfactory explanation of an essentially similar phenomenon.

The observation is that nebular spectrum lines are less refrangible than lines emitted here and now from (presumably) similar atoms. We all agree to express the problem thus raised by asking why the frequency of old nebular light is smaller than that of young terrestrial light from similar atoms.

Kinematical relativity answers in terms of arbitrarily chosen time-scales, of which two are particularly relevant: (a) the *kinematic* scale (t -time), in which all 'rigid' bodies are expanding and separating, but the frequency on emission of light from a particular *ind* of atom (Z) is the same at all times, (b) the *dynamical* scale (τ -time), in which the sizes of and distances between rigid bodies remain constant, but the frequency on emission of light from Z is greater the later it is emitted. The red-shift, it is held, is explicable on either scale, but this I cannot see.

Consider first the t -scale. The frequency on emission is the same at all times, but the nebula is receding. Only two causes of red-shift are then conceivable: (1) relative motion of earth and nebula, (2) decrease in frequency of *light* (not atomic processes) during passage through space. General relativity accepts (1), but kinematical relativity cannot do so because it holds that even *relative* motion can be transformed away mathematically, and we cannot attribute an objective fact to a cause destructible by "an arbitrary act on the part of the hinker"³. Neither is (2) available, for in his comments⁴ on Prof. Haldane's paper, Milne says (this seems also to be implied in previous papers, but I have not before seen so unambiguous a statement): "This degradation of the individual photons due to interacting with matter must be distinguished from their constancy of frequency in time (t -scale) as they are propagated through empty space". The only possibility left thus seems to be the arbitrary postulate that inter-nebular space contains matter which affects light in a way unknown elsewhere in nature. This has not to my knowledge been suggested,

and would be a purely *ad hoc*, and therefore worthless, explanation.

The same difficulty in different form is, of course, experienced on the τ -scale. Here the sizes of bodies (and therefore of the atoms which compose them) remain constant, but *atomic frequencies* change with time. Hence atomic frequencies must depend on something unstated which does not affect the linear dimensions, thus apparently ruling out all possibility of correlating radiation with atomic structure. Moreover, if inter-nebular matter is to be admitted, we must suppose its effect on light-frequencies to be exactly neutralized by an *ad hoc* change of light-frequency (on the τ -scale) during propagation through space, for the explanation is complete without change of frequency after emission. But change with propagation, even on the τ -scale, is denied by Milne⁵, so the inter-nebular matter essential on the t -scale becomes fatal on the τ -scale. Kinematical, unlike general, relativity therefore appears unable to account for the red-shift.

This comparative impotence seems to depend ultimately on the restriction of observations to readings of a single clock, which are insufficient data for describing the full variety of physical experience. Consider a missile which, by ordinary measure, is approaching an observer. By the principle which is held to validate the t and τ scales, the observer can properly regard its distance as remaining constant. He has simply to send a beam of light to and from the missile without pause, and regard its successive returns as equally spaced in time. The ultimate impact then does not occur until $\tau = \infty$ on this scale, and so causes no mathematical embarrassment unless the observer survives, but the comfort thus afforded is perhaps questionable. A portion of the observer's experience is made inaccessible in the description given by kinematical relativity, but it is perfectly accessible to him. One cannot help recalling Achilles and the tortoise.

It would, I believe, give satisfaction to many who find a genuine difficulty here if some kinematical relativist would (if possible at no greater length and with no more recourse to mathematics than this letter has required) explain how the theory meets the objection I have tried to express. It is clearly desirable that, before the valuable time of men like Prof. Haldane is further employed in making unverifiable deductions from the theory, we should be assured that the theory can satisfactorily account for what we do experience.

HERBERT DINGLE.

Imperial College of Science and Technology,
London, S.W.7.
Feb 26.

¹ *Nature*, 155, 133 (1945).

² *Nature*, 155, 234 (1945).

³ Milne, E. A., *Astrophys. J.*, 91, 167 (1940).

⁴ *Nature*, 155, 136 (1945).

⁵ *Proc. Roy. Soc. A*, 158, 328 (1937).

PROF DINGLE makes Prof. Haldane's contribution to kinematical relativity the occasion for what he thinks is an attack on its foundations. He is very simply answered: the red-shifts in the spectra of the galaxies are described in kinematical relativity as a Doppler effect due to recession. The consequences of this in relation to the ageing of light and Prof. Haldane's work have been discussed by me in a letter to *Nature* written before I saw Prof. Dingle's letter.

I see no reason to take up Prof. Dingle's challenge to answer his misunderstandings without the use of mathematics. The consequences which he finds so difficult are *mathematical* deductions from a simple model of the expanding universe; I attach no weight whatever to the verbal descriptions I have occasionally attempted—the core of the matter lies in the mathematics. Prof. Dingle takes from time to time certain English sentences of mine and criticizes their content, but I have never felt that he has understood the theory itself, as embodied in the mathematics. It is no use objecting to the results themselves, the critic should find flaws in the trains of mathematical deduction. When Prof. Dingle finds such flaws, I shall be the first to examine the situation, and to attempt to correct the conclusions. Until then, I have nothing to add to my constructive papers.

Prof. Dingle's attempt to pour ridicule on some of the consequences of kinematic relativity reminds me of Bishop Wilberforce's attempt to discredit the theory of evolution. It is the fate of most essentially new theories to be either ridiculed or ignored. Prof. Dingle should remember, for example, that the ideas of non-Euclidean geometry took a long time to become accepted—they are *prima facie* as absurd as he makes out kinematic relativity to be. I have no personal responsibility for the deduction that the Newtonian scale of time is not the scale of time in which the galaxies are receding; it is an inevitable consequence of the circumstance that the equation of motion of a free particle, at large among the receding galaxies, comes out to be non-Newtonian, but becomes Newtonian when the logarithmic change of time-scale is applied. One of the fundamental problems of physics is the question whether the dynamical scale of time is identical with that corresponding to the recession of the galaxies, and to this problem kinematic relativity finds a solution.

I would add that I have repeatedly shown that clock-readings alone are adequate to give measures of epoch and distance—this lies at the basis of modern determinations of *range* (for war-like purposes) by radar, that general relativity, unlike kinematic relativity, is unable to incorporate the essentially *forward* march of time, and that Prof. Dingle uses an antiquated theory of causation which plays no part in kinematic relativity.

E. A. MILNE

Relationship between Nuclear Force and Gravitational Force

ALL we know of nuclear force is that it is of the short-range type. Its analytical form is still obscure, and the meson theory of its origin is, up to the present, inconclusive, to say the least.¹ On the other hand, gravitational force is explained by the theory of general relativity. Temporarily disregarding the theory of general relativity and considering only the important fact that both nuclear force and gravitational force are attractive, let us assume that they are of the same origin. Let us tentatively take the function

$$V = -AeK/r \quad (1)$$

as the mutual potential between any two nuclear particles, for example, between two protons, two neutrons or one proton and one neutron, with A and K as constants. Then, as the distance r between

the particles becomes much larger than K , equation (1) becomes

$$V = -A' - \frac{AK}{r} \quad (2)$$

In this expression, the first term on the right-hand side is a constant and therefore can be neglected. Thus

$$V = -\frac{AK}{r} \quad (3)$$

On the other hand, the gravitational potential between the two nuclear particles of masses M and M' should be given by

$$V = -G \frac{MM'}{r} \quad (4)$$

If the nuclear force and gravitational force are really of the same origin, we must have, from (3) and (4)

$$AK = GMM' = 1.83 \times 10^{-55} \text{ erg. cm} \quad (5)$$

since $G = 6.66 \times 10^{-8}$ and $M = M' = 1.66 \times 10^{-24}$. Recently, Ragan, Kanne and Taschek², from the proton-proton scattering experiment, found that the potential between two protons can be represented by a rectangular well of width $2 \frac{e^2}{mc^2}$ and depth

10.5 Mev. Now, if from our equation (5) we make the Compton wave-length of the electron, that is $K = \hbar/mc = 3.83 \times 10^{-11}$ cm, we get $A = 4.80 \times 10^{-4}$ and if we substitute these values of K and A into (1)

we find the potential $V = 10.5$ Mev. at $r = 1.51 \frac{e^2}{mc^2}$ which is only slightly smaller than the experimental

value of $2 \frac{e^2}{mc^2}$. In fact, if the potential is not

straight rectangular well but a slightly curved one for the same depth of potential a smaller value of V would be expected. If, instead of the equation (1) we take

$$V = -\frac{B}{r} eK/r = -\frac{AK}{r} eK/r \quad (6)$$

as the nuclear potential function, we get the result

$V = 10.5$ Mev at $r = 1.62 \frac{e^2}{mc^2}$, which agrees even

better with the experimental value. Thus we may tentatively state that

$$V = -\frac{B}{r} eK/r \quad \text{for } r > a$$

$$V = -\frac{B}{a} eK/a \quad \text{for } r \leq a \quad (7)$$

for a certain value of a . Since the value of K is not purely arbitrary, but is chosen as the Compton wave-length of the electron, the agreement between the experimental and the calculated value is perhaps not accidental, and may indicate that the electron, as has long been suggested, plays an important part in nuclear interactions. If it is required to avoid the rather artificial way of 'cutting off' the expression (7) at $r = a$, we give an alternative expression

$$V = -Ae \left[\frac{K}{r} - \left(\frac{K'}{r} \right)^n \right]$$

with n lying between 1 and 2, and K' a new constant which may tentatively be put as the Compton wave-

length of the meson, that is, $K' = \frac{\hbar}{m'c} \approx \frac{\hbar}{180 m_e c}$

but this makes the width of the potential well smaller than $1.51 \frac{e^2}{mc^2}$.

It has been shown by M. S. Wang³ that satisfactory values for the binding energy of the deuteron and the scattering cross-section of protons by fast neutrons can be obtained if either of the potential function (1) or (6) is used. It may also be mentioned that since, of all the fundamental particles, the neutrino is the only one the interaction of which with others is, up to the present, entirely obscure, it is possible that the gravitational field is simply a neutrino field which alone, or together with the electron field, causes material entities to attract each other.

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¹ See, for example, Bethe, H. A., *Phys. Rev.*, **57**, 260, 390 (1940).

² Ragan, G. L., Kanne, W. R., and Taschek, R. F., *Phys. Rev.*, **60**, 628 (1942).

³ Wang, M. S., unpublished.

Action of Ionizing Radiations on Carotene and Vitamin A

MANY authors¹ have directed attention to the chemical effects of ionizing radiations, with the view of elucidating the sequence of events between the actual absorption of ionizing radiations in tissues and the biological effects which are known to be produced in radiotherapy. Experiments on enzyme and hormone preparations² have shown that the action of ionizing radiations upon aqueous solutions is indirect. It is well known that genetic mutations may be produced by ionizing radiations³, possibly by a direct effect on the hypothetical macro-molecule of the gene.

Some observations are recorded below on provitamin A (β -carotene) ($C_{40}H_{56}$) and vitamin A ($C_{20}H_{30}OH$), indicating that the effect on these fairly large molecules is direct.

It was observed some time ago⁴ that ($\beta + \gamma$) rays from radon in glass capillaries would bleach butter at a range of 8–9 mm from the capillary. It was later established that the colour of butter is due to carotenoids (c. 94 per cent carotene, 6 per cent xanthophylls). Carotene isomers and vitamin A are normal constituents of human blood. In mammals generally, carotene is converted *in vivo* to vitamin A, relatively large quantities of which are stored in the liver. Apart from quite small amounts of carotene in yellow bone-marrow and body fat, mammals store little carotene, and the normal blood-level is only maintained as the result of day-to-day intake of dietary carotene (green vegetables, carrots, butter, etc.). It is obviously of interest to determine the effect of ionizing radiations used in radiotherapy on carotene and vitamin A.

In one series of experiments, it was established that $\beta + \gamma$ rays from radon in glass capillaries and also γ rays from radium in platinum containers destroyed the carotene and vitamin A in butter. Since butter contains c. 15 per cent of water, it was possible that the primary action of the radiation was to activate the water. To test this point, a sample of molten whey butter fat (containing little or no water) was irradiated at 45°C using a current of nitrogen for the dual purpose of stirring and providing a non-oxidizing atmosphere. The destruction of carotene

and vitamin A was complete after exposure to radon in glass capillaries (150 mc. 48 hr). Further, crystalline β -carotene dissolved in pure *n*-hexane was also destroyed, so that effects due to water and oxygen were excluded. Vitamin A, in the form of a rich ester concentrate dissolved in *n*-hexane, was likewise destroyed. In view of the difficulty of estimating the dose in r units from $\beta + \gamma$ rays of radon in glass capillaries, parallel experiments using therapeutic doses of X-rays at 220 kV and 1,000 kV. were carried out with β -carotene in *n*-hexane. In a series of experiments it was found that the 'ionic yield' M/N (M is the number of molecules destroyed, N is the number of ion-pairs produced) was nearly unity, and in one test, at a favourable concentration, exactly unity.

Carotene and vitamin A were present in the butter used in concentrations of 16 I.U./ml. and 20 I.U./ml. respectively (I.U. = 0.6 μ gm. β -carotene), and in blood serum at concentrations of 1–2 I.U./ml. and 0.7–1.3 I.U./ml. respectively.

The action of ionizing radiations on carotene concentrations of 1,000, 100, 10 and 1 I.U./ml. has been tested. The proportion M/M_0 (M_0 is number of molecules present initially) of molecules inactivated is greater in the dilute solutions, as would be expected.

In concentrations of 1 I.U./ml., the absorption of only 64 r of radiation would produce an inactivation of 10 per cent of the molecules. The effect thus approaches in sensitivity Dale's experiments² on the inactivation of enzymes in dilute aqueous solution. These results made it feasible to examine *in vitro* the effect of therapeutic doses of ionizing radiation on the carotene and vitamin A of human blood serum. It was found that 6,000 r of X-rays produced no detectable change, and that exposure to ($\beta + \gamma$) radiation to an extent estimated at 50,000 r was needed to destroy the carotene. The colour-test for vitamin A became quite anomalous (λ_{max} at 595 m μ instead of 617 m μ), which made it difficult to estimate the loss accurately, but probably half the vitamin was destroyed. The nature of the chemical change which causes the colour test maximum to be displaced in this way is imperfectly understood.

The net result of this preliminary work is to establish that there is a direct action of ionizing radiations on provitamin A and vitamin A with an ionic yield of approximately unity in non-aqueous media. The effect is irreversible and is almost certainly accompanied by a loss of physiological activity. In human blood serum the vitamin and provitamin are protected in some way, with the result that by the criterion here adopted, the ionic yield is reduced to 0.01.

Further experiments are in progress and a detailed account will be established elsewhere. One of us (R. A. M.) is indebted to the Medical Research Council for assistance.

T. A. CHALMERS
T. W. GOODWIN
R. A. MORTON

Radium Institute,
Biochemistry Department,
University of Liverpool
March 8

¹ Allsopp, C. B., *Trans. Faraday Soc.*, **40**, 79 (1944).

² Dale, W. M., Meredith, W. J., and Tweedie, M. C. K., *Nature*, **151**, 280 (1943).

³ Pontecorvo, G., and Gemmell, A. R., *Nature*, **154**, 532 (1944).

⁴ Failla, G., Adair, F., Qumby, E. H., and Sugura, K., *Amer. J. Roentgenol. N.Y.*, **15**, 11 (1926).

Role of Structural Homo- and Heterozygosity in Mosaic Formation

AN investigation into the nature of mosaicism and the regularities of inheritance of mosaic characters in *Drosophila melanogaster* has revealed two essentials. Mosaicism of the ever-sporting displacement type is always connected with a chromosome re-arrangement involving heterochromatin regions of chromosomes. Insertion of extra heterochromatin of X- or Y-chromosome or arms of the latter causes strong suppression of mosaicism.

As my investigations have shown, one of the peculiarities of heterochromatin action in mosaic formation is the maternal effect, that is, extra heterochromatin of the mother greatly decreases the development of mosaic individuals among those of her offspring that have no extra heterochromatin. Further investigations have now shown that the influence of heterochromatin in mosaic formation also exists in the form of a paternal effect. The two types of influence are not specific for any one mosaic strain but are inherent in all mosaic forms of the type of ever-sporting displacements.

The discovery of the paternal and maternal effect of heterochromatin in mosaic formation as well as the uniformity of its action was sufficient to suggest some general mechanism for these phenomena. The existing point of view according to which the action of heterochromatin is to be considered as the result of the breaking down of the quantitative balance between the hetero- and eu-chromatin of the chromosomes of the nucleus is not in agreement with these results.

By studying the influence of different heterochromatin components of chromosomes in a number of mosaic strains, I have collected a large body of data which has made it possible to analyse the regularities of the influence of heterochromatin in mosaic formation. The regularities found are as follows: (1) All heterochromatic components of chromosomes are able to suppress the development of mosaic characters. (2) The influence of extra heterochromatic components in mosaic development is found to exist in the form of a maternal, paternal or immediate (direct) effect. The results of the last-mentioned may be complicated by the additive influence of maternal or paternal effects. (3) Simple quantitative relations of heterochromatin action in mosaicism take place only in the case of the immediate effect when maternal or paternal effects are absent. When these latter are involved, simple quantitative regularity of heterochromatin influence in mosaicism breaks down. (4) Maternal and paternal effects do not follow from simple quantitative relations of hetero- and eu-chromatin, their effect being absent or present even if the quantitative relations of hetero- and eu-chromatin are the same. Only in the case of structural homozygosity of heterochromatin components of the chromosome does the maternal or paternal effect of the influence of heterochromatin in mosaicism take place. In the case of structural heterozygosity both are absent.

Structural homozygosity, in my opinion, means a structural identity in relation to heterochromatin components of chromosomes that secures the complete conjugation of the chromosome during meiosis and possibly during mitosis. It is necessary to emphasize that the term 'structural homozygosity' does not necessarily imply recognition of the pairing of heterochromatin regions, but only recognition of the possibility of their conjugation.

The influence of heterochromatin components of chromosomes in mosaicism in the form of maternal or paternal effects is transmitted from the parents to their offspring by the heterochromatin component themselves, no matter whether heterochromatin is present from a Y-chromosome or from one of its arms, from an X-chromosome or any autosome or from the heterochromatin of a re-arranged chromosome or scute-eight type.

Under the influence of structural homo- and heterozygosity there take place qualitative changes of chromosomes depending upon intracellular processes. I have shown that in homozygous scute-eight females, genetic differences between X-chromosomes can be observed. A chromosome transmitted by the father, owing to its structural heterozygosity, is qualitatively different from one transmitted by the mother.

My genetic studies were verified by cytological investigations (by Prokofieva-Belgovskaya). According to these, one of the X-chromosomes in homozygous scute-eight females has a *heterochromatized* yellow achæte region, while in the opposite X-chromosome this region is *euchromatized*. These differences may go so far as to make the distal ends of the X-chromosome unable to conjugate at all.

Quantitative changes of chromosomes resulting from the influence of structural homo- and heterozygosity are not connected only with mosaic strains. They arise in every stock where the appropriate conditions above mentioned are present. Owing to the instability of its features, mosaicism is only a sensitive indicator, allowing us to detect these qualitative changes of chromosomes.

Since extra heterochromatin leads to euchromatization, it is possible to say that structural homozygosity leads also to euchromatization of chromosomes, while structural heterozygosity leads to heterochromatization of their parts. It is the cause of increased frequency of mosaic individuals under conditions of structural heterozygosity and decreased frequency under conditions of structural homozygosity in genetic structures of type scute-eight. I believe that the phenomenon of heteropycnosis which heterochromosomes undergo in spermatogenesis is the result of structural heterozygosity of X-Y composition. XX composition, being of homozygous structure, does not show heteropycnosis during oogenesis.

Using the phenomenon of structural homo- and heterozygosity in chromosome changes, I have obtained stable changes that have been transmitted during many generations without any decreasing effect.

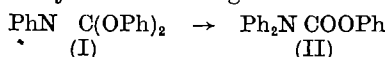
The data described above enable us not only to understand the nature of mosaicism and the nature of the influence of heterochromatin in mosaicism but also to regard structural homo- and heterozygosity as one of the essential intracellular factors responsible for causing stable changes in chromosomes and then genetic peculiarities. This throws new light on the problem of hybridization, as a factor of variability responsible not only for recombinations of parental characters, but also for new qualitative changes. The importance of the latter is enhanced in the light of recent data on the presence of intrachromosome inert regions, and on the role of chromosome rearrangements among natural populations.

N. J. NOUDIN

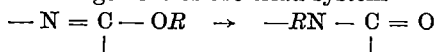
Academy of Sciences,
Moscow

Molecular Rearrangement of Arylimino Diaryl Carbonates

In the course of work on the properties of arylimino diaryl carbonates, we have found that phenylimino diphenyl carbonate (I)^{1,2} rearranges quantitatively to phenyl diphenyl carbamate (II)⁴ on heating at 360° for one hour, or on slow distillation at c 360° no by-products could be detected, and no indication of reversibility of the rearrangement could be found.



This rearrangement of the triad system



recalls the observations of Chapman⁵, who found that N-phenyl benziminophenyl ether, PhC(NPh)OPh, rearranged irreversibly to give N-benzoyl diphenylamine, PhCONPh₂, on heating for one hour at 70–300°

We have been unable to demonstrate a similar rearrangement of the sulphur analogue of (I), phenylimino diphenyl dithiocarbonate PhN·C(SPh)₂, prepared from phenyl carbylamine chloride and sodium thiophenolate. This compound remained unchanged on heating at 330°, and on distillation at c 370° was recovered unaltered, though a little disruptive decomposition may have occurred, indicated by the colour of thiophenol produced. This finds a parallel in the work of Chapman⁶, who found that the sulphur analogue of N-phenyl benziminophenyl ether, namely, PhC(NPh)SPh, remained largely unchanged under conditions which sufficed for the complete rearrangement of the former. At higher temperatures (> 320°), however, decomposition occurred giving products indicative of reversible rearrangement having occurred.

Unsymmetrical analogues of phenylimino diphenyl carbonate, PhN·C(OR₁)(OR₂), where R₁ and R₂ are aryl or aryl groups, have been prepared via the nitrochloride PhN·CCl(OR), and work on their rearrangement, aimed at determining the relative ease of migration of different groups, is in progress and will be reported in full elsewhere.

The rearrangement affords a convenient method for the synthesis of unsymmetrically substituted derivatives of phenyl diphenyl carbamate and hence of phenylamines.

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¹Antzsch and Mai, *Ber*, 28, 9827 (1895)
²German Patent 230827 (Frdl 10, 1322)
³Wyson and Harrington, *J Chem Soc*, 151 (1942)
⁴Sellman and Bonhofer, *Ber*, 20, 2122 (1887)
⁵*Chem Soc*, 1992 (1925)
⁶*Chem Soc*, 2296 (1926)

Green Pea Juice as a Medium for the Production of Penicillin

AQUEOUS extracts of ground dried peas form a good medium for the production of penicillin¹. There are, however, certain disadvantages in the use of such material on a large scale, although it forms a very convenient basis for a scheme of fractionation of the active constituents concerned². Last summer we found that a press juice made from entire green peas (seeds and pods) formed an excellent medium for penicillin production. 2,200 gm of entire peas were put through a juice tractor and yielded 1,450 ml (1,520 gm) of juice.

A medium was made up containing NaCl 10 gm, NaNO₃ 3 gm, KH₂PO₄ 0.5 gm, MgSO₄·7H₂O 0.25 gm, lactose 30 gm, pea juice 100 ml and tap water to 1 litre. The pH was 5.8. After mixing well and bringing to the boil, the medium was clarified either by passing through paper pulp or by centrifuging.

The medium was placed either in 40 ml amounts in 250 ml conical flasks or 200 ml amounts in Roux bottles. After autoclaving for 15 min at 15 lb pressure the medium was seeded with a culture of *Penicillium notatum* 1,249 B 21. The flasks were incubated at 24°. Flasks containing the Coghill medium were set up at the same time.

Penicillin production was assayed both by the dilution method and by Brodie's³ method. Typical results obtained were: Pea medium 150 units per ml after 9 days, Coghill medium 150 units per ml after 9 days. With both media values ranging from 125–225 units per ml were found in different flasks.

A striking feature of the pea medium is the rapid covering of the surface of the culture medium.

Yields of 80–100 units per ml were obtained with the diluted pea juice to which only sodium chloride had been added. The residue left after making the pea juice is inactive. The pea juice may be preserved either in a dry form or in the frozen state. The cost of peas to prepare such a medium would be, for peas at 54s per cwt, 9d–10d per gallon of medium.

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 March 3

¹Cook, R. P., and Tulloch, W. J., *J. Path. and Bact.*, 56, 555 (1944).

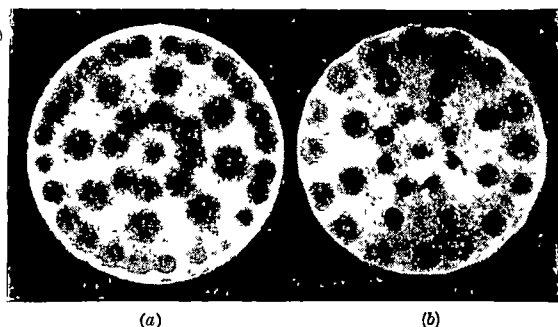
²Cook, R. P., Tulloch, W. J., Brown, M. B., and Brodie, J., in the press (1945).

³Brodie, J., in the press (1945).

Assay of the Rates of Secretion of Antibiotic in Different Regions of a Growing Mould Colony

In research on antibiotics, one field is conspicuously blank: that of how a species produces a certain antibiotic. There is no definite answer for any antibiotic to even such elementary questions as: Is the metabolism of the antibiotic linked up with cell multiplication and growth? Is the antibiotic an intra- or extra-cellular metabolite? Is it secreted from the same cells that produce it, or is it secreted from a different part of the mycelium? A technique which may help in solving parts of these problems has now been worked out.

Colonies are grown on disks of permeable 'Cellophane 600' over a very dilute agar medium (for example, Czapek-Dox diluted fifty times). The medium may be kept constant, if the aim of the experiment requires it, by transferring the 'Cellophane' disk with the colony to another Petri dish as often as necessary. When the colony has reached the desired diameter, it is transferred for periods of one hour three or more times on to fresh medium. This removes any appreciable amount of lingering antibiotic. The colony is then transferred on to hard (3 per cent) agar 3 mm deep and left there for a short time (10 min–1 hr) the antibiotic secreted during this time diffuses into the agar. The colony is removed and can be tested again if required. The region of the agar over which the colony was lying is immediately punched all over with a glass tube 3 mm in diameter. The resulting small cylinders of



agar impregnated with antibiotic are then put, face down, on the surface of a testing agar medium (for example, the usual agar-nutrient, *Staphylococcus*). They are arranged in the same disposition as originally, but with proportional increases in the distances between them. The size of the inhibition ring formed after incubation around each agar block gives an estimate of the amount of the antibiotic secreted into the block by the small region of the colony which was in contact with it for the time of testing, that is, an estimate of the rate of secretion.

In the accompanying reproductions, (a) shows an assay on a 10 cm Petri dish of a 5 cm colony of a good strain of *Penicillium notatum*. The rate of secretion of the antibiotic is at its minimum at the centre and the growing edge of the colony, at its maximum about 1 cm behind the growing edge. A good rate is kept up for a considerable distance towards the older parts of the colony. Assays on a 'poor' strain present the same trend (b), but in this case the high secretion is of short duration (growing edge not assayed in this photograph). If synthesis and secretion occurred at the same place, one could deduce that in this species the antibiotic is a metabolic product of already established hyphae, it is not directly connected with cell-multiplication, and its production falls off in old cells, less rapidly so, however, in a good than in a bad strain. By this technique the different rates of secretion of different 'sectors' of a colony can also be estimated.

I am indebted to Mr P. Bruce White for a most helpful suggestion without which this technique could not have been refined.

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Hæmoglobins of *Ascaris lumbricoides* var *suis*

ALTHOUGH hæmoglobin has been recorded in a number of species of parasitic nematodes, the occurrence of the pigment in this class of invertebrates, as in most of the others, is sporadic. Little work has been done upon the properties and function of these nematode hæmoglobins.

Keilin observed¹, in *Ascaris lumbricoides* from the pig, two hæmoglobins which differed from each other, and from the hæmoglobin of the host, in the position of the bands in the absorption spectra. The perienteric fluid and body-wall of the parasite each contained a characteristic hæmoglobin. Some further observations have now been made upon these pigments.

When *Ascaris*, kept under strictly anaerobic conditions, was observed spectroscopically, the oxy-

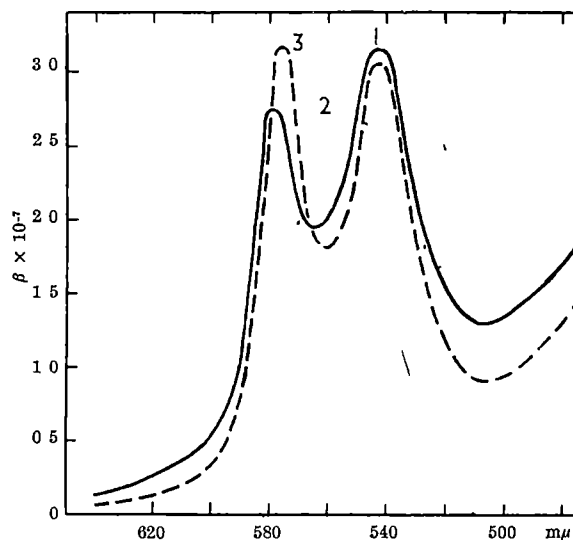
hæmoglobin of the body wall was seen to become deoxygenated. Extracts of this hæmoglobin proved to have a very high affinity for oxygen, it being impossible to secure complete deoxygenation of the oxyhæmoglobin by equilibrating against a vacuum at 20° C. Sodium hyposulphite, which rapidly takes up oxygen in solution, produced a slow deoxygenation. Thus *in vacuo* at pH 7 and 8° C., 250 sec (t_{50}) were required for half dissociation of the oxygen from the hæmoglobin.

Spectrophotometric measurements upon concentrated extracts revealed that the body-wall oxyhæmoglobin has a spectrum of unusual type (Curve 1). The α -band is narrower and less intense than the β -band. Keilin and Wang have recently described an oxyhæmoglobin from the root nodules of a leguminous plant which has a spectrum of similar form. The spectra of other animal oxyhæmoglobins which have been described hitherto have bands of approximately equal height, resembling those of the human oxyhæmoglobin shown in Curve 3. The deoxygenated body-wall pigment has a normal spectrum (Curve 2).

A still greater resistance to deoxygenation is shown by the perienteric fluid oxyhæmoglobin. Under the influence of sodium hyposulphite *in vacuo* at 8° C. and pH 7, $t_{50} = 1,000 \pm 100$ sec. The reaction thus proceeds about four times more slowly than with the body-wall pigment. The effects of various factors upon the velocity of deoxygenation were examined.

(1) An eight-fold variation in the concentration of the reducer was without effect upon the reaction velocity. The reaction is therefore not an oxidation-reduction but a true deoxygenation.

(2) Assuming the temperature effect follows the Arrhenius equation, extrapolation from the curve of temperature against reaction velocity to 37° C. gave a value t_{50} of about 150 sec. Hartridge and Roughton³ deduced that, for sheep hæmoglobin, t_{50} at 37° C. was 0.0025 sec.



ABSORPTION SPECTRA OF (1) OXYHÆMOGLOBIN OF THE BODY WALL OF *Ascaris*, (2) BODY WALL HÆMOGLOBIN, (3) HUMAN OXYHÆMOGLOBIN. ORDINATES: THE ABSORPTION COEFFICIENT

$\beta = \frac{1}{cd} \log_e \frac{I_0}{I}$, WHERE c IS THE CONCENTRATION OF HEMATIN EXPRESSED AS gm. mol./c.c., d IS THE DEPTH OF THE ABSORBING SOLUTION IN cm., I_0/I IS THE RATIO OF THE INTENSITIES OF INCIDENT TO TRANSMITTED LIGHT. ABSCISSAE ARE WAVE-LENGTH OF LIGHT IN μ .

The spectrum of the perienteric fluid oxyhæmoglobin is of the same type as that of the body-wall pigment

The main derivatives of the *Ascaris* pigments were prepared and were found to be related to each other in the manner characteristic of hæmoglobin derivatives. Such differences as were observed in the mode of their formation could be attributed to the low deoxygenation velocity of the oxyhæmoglobins.

Millikan^{4,5} has shown that interspecific differences in the oxygen affinities of hæmoglobins are the result chiefly of variations in the velocity of association of the pigments with oxygen. He found the dissociation velocities to be of the same order in hæmoglobins having widely different oxygen affinities. The hæmoglobins of *Ascaris* depart from this rule. Oxygen dissociates from the perienteric fluid hæmoglobin 10,000 times, and from the body-wall hæmoglobin 2,500 times more slowly than it does from sheep hæmoglobin.

The ability of *Ascaris* to deoxygenate the hæmoglobin of the body-wall provides evidence that this pigment may have significance as an oxygen carrier at the low tensions of the gas which prevail in the mammalian gut. Laser has shown⁶ that the oxidative enzymic system of the parasite is well adapted to such low tensions of oxygen.

A pigment having similar spectroscopic properties and oxygen relations to that of the perienteric fluid of *Ascaris* was found to occur in the perienteric fluid of *Strongylus* sp. from the horse.

A more detailed account of this work will be published elsewhere.

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Keilin, D., *Proc. Roy. Soc.*, B, 98, 312 (1925)

² Keilin, D., and Wang, Y. L., *Nature*, 155, 226 (1945)

³ Hartridge, M. D., and Roughton, F. J. W., *Proc. Roy. Soc.*, A, 104, 395 (1923)

⁴ Millikan, G. A., *J. Physiol.*, 79, 158 (1933)

⁵ Millikan, G. A., *Proc. Roy. Soc.*, B, 120, 366 (1936)

⁶ Laser, H., *Biochem. J.*, 38, 333 (1944)

'Ant Butter'

RECENTLY my father-in-law, M. Platonoff, asked me whether I could give him any information concerning a soft pliable yellow substance which he had found in the nests of wood ants in the forests of the U.S.S.R. The substance was in the form of small lumps and was sought by the peasants, who termed it 'ant butter' (Mourovenue Maaslo). He did not know for what purpose the peasants used it. It is said that bears seek the 'ant butter', and a disturbed ants' nest used to be taken as an indication of their presence.

This substance was undoubtedly the ant 'incense' of Linnaeus. The occurrence of ant 'incense' ('wirak') was first recorded by Linnaeus¹, who described ants collecting resin from juniper bushes and stated that the peasants gathered the pieces of resin from the nests of *Formica rufa* L. and used it as incense, terming it 'wirak'. Wheeler² points out that this is probably derived from the German "Weihrauch", incense. De Geer³ both records and also figures the resin, and states that the wood ants collect it from the pine and fir trees. He says "the ants collect it [the resin] in little masses of irregular form and varying size, of which the colour is sometimes white, sometimes yellow, and often of a dirty white, the

substance is more or less hard except for that which has been amassed fairly recently."

Réaumur⁴ experimented by placing bits of resin in ants' nests, "to see whether they will take on the peculiar quality that makes them resemble myrrh or amber." He also had some correspondence with De Geer on the subject.

Donisthorpe⁵ states that "In Northumberland and Scotland these ants (*Formica rufa*, L.) collect huge quantities of yellow resin—'ant amber'—from the fir trees, I have seen nests full of it."

I have often observed wood ants climbing pine trees in the New Forest (presumably to collect resin) and coming down with their crops full, but have never actually seen the 'ant amber'.

The practice of collecting resin seems to be a widespread habit among the wood ants of the coniferous forests and woods of Europe, but I know of no record of this behaviour from America, nor has anyone yet determined for what purpose, if any, the ants use the resin.

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¹ *Vetensk. Akad. Handl.*, 37 (1741)

² Réaumur, "The Natural History of Ants" (trans. by Wheeler), 226 (New York, 1926)

³ "Mémoires", 2, Pt. 2, 1066 (1771), (Fig. 15 of plate 41)

⁴ *loc. cit.*, p. 123 and p. 213

⁵ "British Ants", 2nd edition, 291 (London, 1927)

Protein Content of Earthworms

CERTAIN historical events in 1940 interested us in the possible dietetic value of the protein content of earthworms. We found that two Germans¹ and two repetitive Japanese² had shown that all the usual amino-acids produced by hydrolysis of mammalian protein were also obtained from earthworms (*Lumbricus terrestris*), but they gave no quantitative figures of total protein with which we were concerned and which we now report.

Technique. We dealt with common earthworms of a variety of colours and sizes dug from Wiltshire and the London area. At first we analysed worms after keeping them 4–6 days in moss or oatmeal (the scouring process employed by anglers), but found that much 'earth' matter remained, varying from 25 to 45 per cent of the fresh weight. We therefore took large worms, killed them in ethyl alcohol, split and washed them earth-free and dried them roughly to their original moisture. Of these a known weight (sometimes one worm, sometimes two to four) was then desiccated and the nitrogen estimated by Kjeldahl ($P = N \times 6.25$).

	1	2	3	4	5
Fresh worm (cleaned) (gm.)	4.66	8.0	5.0	15.0	26.0
Desiccated (gm.)	0.91	1.66	0.95	2.2	3.7
Water (per cent)	80.4	79.0	81.0	86.0	85.0
Protein, dry worm (per cent)	71.5	62.0	62.0	69.0	71.0
Protein, fresh worm (per cent)	13.95	12.9	11.7	9.9	10.0

Total fat estimation (ether and petroleum ether extracts) on three uncleaned samples were 1.3, 1.0 and 0.76 per cent of fresh weight, equals 1.5 per cent average on the de-earthed worm.

The free sugar or total carbohydrate was not estimated.

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¹ Ackermann, D., and Kutscher, F., *Z. Biol.*, 75, 315 (1922)

² Murayama, Y., and Aoyama, S., *Yakugakuzasshi*, No. 469, 221 (1921), No. 484, 482 (1922)

RESEARCH ITEMS

Avian Tumour Virus and 'Carrier' Hens

It is stated that losses in poultry flocks due to neoplastic diseases amount to 20 per cent or more, and despite the urgency of the problem of etiology and control of avian cancer, there is little information which can be used as a basis for prevention. Although it is not known whether all spontaneous tumours are virus-induced, most of the successfully transplanted sarcomas were found to be associated with a causative virus. Susceptibility to Rous No. 1 filterable sarcoma is inherited, and resistant birds frequently respond to infection by this virus by the production of no growth or by a small and transient growth. The virus remains latent in these birds for years after clinical recovery from the infection. Fowl-tumour viruses are disseminated about the body of a host bearing a freshly induced filterable tumour and, although such fowls have only a brief reproductive period left, the virus passes to the egg and hence to the offspring of the tumour-host. The laying capacity of the 'carrier' fowls, on the other hand, appears not to be affected, and it would be expected that their immunity would be passed similarly to their eggs. In attempting to find whether these virus 'carriers' might be responsible for the spread of malignant diseases in such flocks, J. G. Carr (*Proc. Roy. Soc. Edin.*, 52, B, 54, 1944) has investigated the neutralizing ability of the eggs of the 'carriers' and of normal hens and has found that 'carriers' lay eggs which contain a considerable amount of virus-neutralizing antibody in the yolk. Virus could not be detected in the egg-embryo or chick from such birds, nor did the 'carriers' infect other birds in the same pen with the sarcoma virus. The fact that no neoplasms developed in a flock which, by careful husbandry, had been raised free from parasites or infectious diseases, suggests the elimination of some factor operating in ordinary flocks.

Feeding Apparatus of Biting and Sucking Insects

Under the above title, R. E. Snodgrass has contributed an important paper in the Smithsonian Miscellaneous Collections (104, No. 7, Oct. 1944). This work is an extension of the same author's previous memoir on the feeding apparatus in biting and disease-carrying flies published in the Smithsonian Miscellaneous Collections for July 1943. The letterpress and illustrations in the last-named paper are included in the new publication, while the additional matter comprises accounts of the feeding organs of Anoplura, Siphonaptera, Thysanoptera and Hemiptera. Dr. Snodgrass's work supplements, and also brings up to date, the accounts given of those organs in present-day text-books. It makes available a thoroughly modern interpretation of the organs of feeding among both biting and sucking insects. For this reason it will be found to be a valuable aid to students and teachers of medical entomology in particular. The general entomologist also cannot afford to pass over this paper since the author gives an entirely new interpretation of the morphology of the mouth-parts in the Siphonaptera. The actual organs used for piercing, it is claimed, are not the mandibles, as almost every authority has maintained for many years past, but are the laciniae of the maxillae. A further point of importance is that the median stylet, almost always regarded as the labrum, is interpreted as being the hypopharynx. It is main-

tained that blood is sucked up through the fine channel in this organ and so reaches the gut. This is interesting, and by no means improbable, re-interpretation of the mouth-parts of Siphonaptera must wait the verdict of future embryological study as a likely means of testing its claims.

Germ Cell Cycle in Trematodes

Recent work by W. W. Cort on reproduction of the intermediate stages of digenetic trematodes supports the germinal lineage hypothesis of multiplication of the cells of the germinal line (*Quart. Rev. Biol.*, 19, No. 4, Dec. 1944). It is a polyembryony by which great numbers of germinal cells are produced from the original zygote. These germinal cells remain distinct from the soma of the germinal sacs (sporocysts and rediae) and come to lie in their body cavities. Finally, the germinal cells form the adult gonads and the polyembryony is succeeded by gametogenesis with the production of haploid spermatozoa and ova. The germinal lineage hypothesis maintains that these gametes are the only cells in the entire life-cycle that have the reduced number of chromosomes. The theory therefore disagrees with the early explanation of Steenstrup (1842), who said that reproduction in sporocysts and rediae was a process of asexual budding, with Grobben (1882) who maintained that it was parthenogenesis, and Woodhead (1931) who described in the Bucephalidae ovaries and testes of sporocysts and rediae and who believed that true bisexual reproduction occurred even in the intermediate stages.

Vitamin C in Drumstick Leaf

Of the many rich natural sources of ascorbic acid, some, such as lucerne, rose hip, blackcurrant and gooseberry, have been successfully processed to yield concentrates which can be used in small quantities to meet human daily requirements of this vitamin. In a communication to the editors, T. B. Panse and A. Sreenivasan, of the Department of Chemical Technology, University of Bombay, now suggest adding the leaf of the drumstick (*Moringa oleifera*) to this list since the leaf by titrimetric estimation contains 900-1,100 mgm. ascorbic acid per 100 gm. Furthermore the leaf provides in addition 100-120 mgm. of β -carotene per 100 gm. and is thus richer in this respect than either lucerne or rose hip. Aqueous extracts of drumstick leaves, if sampled during the pre-flowering stage, are reasonably stable, losing only 25 per cent of their ascorbic acid after three days storage. On the other hand, a powerful oxidase system is apparently developed in the leaves when the tree is in flower, so that larger amounts of the vitamin are lost during the extraction. This is particularly marked with the flowers themselves, the ascorbic acid of which is practically instantaneously destroyed in the aqueous extract.

Physiological Specialization of Oat Stem Rust

Newton and Johnson (*Can. J. Research*, Sec. C, 22, Oct. 1944) have identified twelve physiological races of *Puccinia graminis Avenae* in Canada from 2,586 isolates studied during the period 1921-43. Annual surveys of the prevalence of physiological races during this period show that each year races 1, 2 and 5 have comprised the bulk of the oat stem rust in Canada. The predominance of these races has been greatest in the three Prairie Provinces, where barberry is virtually non-existent. In regions where barberry is present, other races of greater range of pathogenicity have been found more frequently. The

occurrence of such races, however, was sporadic until 1943, in which year races 8, 10 and 11 attained a wide distribution, apparently traceable to wind-borne uredospores from the south. There is evidence that the strains of these races present in 1943 remain in the uredospore stage for much longer periods than do strains of the same races collected in previous years, a fact that may have favoured their spread that year. The role of the barberry in the origination of generally virulent physiological races is discussed. The possibility that such races may also originate by mutation is suggested by spontaneous pathogenic changes that occurred in the greenhouse, in a culture of race 3 that gave rise to several cultures of race 7.

Effect of Stock on Grafted Plants

'A LOVER of planting' in the "Complete Planter and Cyderist" (1685) writes "It's manifest that amongst fruit trees of one kind in the same orchard some shall bear better fruit than any of the rest and it's not known what to impute this excellency to than to the rootstocks they were grafted on". The variability in tree growth and development and in fruit quality is greatly reduced by grafting the trees on to clonal rootstocks vegetatively raised and hence of uniform genetical constitution. Nevertheless, trees grafted on to seedling stocks of varying genetical constitution are often remarkably uniform in character. Especially does this seem to be so under American practice, where trees are generally bench-grafted on to 'root pieces' so that the rootstock does not include any stem piece, and R. H. Sudds and P. C. Marth (*Proc. Amer. Soc. Hort. Sci.*, 42, 326; 1943) find that trees on seedling stocks are almost as uniform over a period of nine years as those on a number of clonal stocks, while E. W. Greve (*ibid.*, 337) in experiments with five varieties of apples on their own roots and on seedling stocks reports no greater variability in the grafted trees than in the 'own rooted' ones.

Theory of the Focault Test

S. C. B. GASCOIGNE has discussed (*Mon. Not. Roy. Astro. Soc.*, 104, 326, 1944) a diffraction theory for the Focault knife-edge test. His paper is highly mathematical, and only a brief summary of it is possible. A short account of the theory of the Focault test is given and then a closed expression for the variation of intensity over the mirror with arbitrary error, not necessarily small compared with λ , when it is tested with a knife-edge, is derived. From the equation giving the disturbance $D(x)$, it is shown how the usual explanation of the knife-edge test follows from the diffraction theory by considering the limit of the equation when $\lambda \rightarrow 0$. Examples are then given of a number of commonly occurring errors. The well-known phenomenon of the appearance of fringes on a mirror with a turned edge is explained, and intensity curves for mirrors with central and zonal errors are computed. Most of the work was carried out during the author's tenure of the Michael E. Baker Scholarship, University of Bristol.

Chain Reactions

THE breaking of chains on the walls of the vessel is one of the most characteristic and essential features of chain reactions and was introduced by Semenoff in 1927 and by Hinshelwood in 1928, its existence being quantitatively proved by Trifonoff in 1929. Since then, many mathematical and experimental memoirs on the subject have appeared. N. N. Semenoff (*Acta Physicochim. U.R.S.S.*, 18, 93, 1943)

has now presented a clear account of the theory in a form convenient for applications, partly because he has himself found difficulty in working out experimental results, and partly because serious errors have been made in mathematical papers by other authors. A careful consideration of the possibility of small values of the chain-breaking probability ϵ is presented, and results for spherical and cylindrical vessels are worked out. The effect of inert gases is also considered, and some attention is given to the action of solid dusts as 'anti-knocks'. It is, of course, quite impossible to summarize a paper of this character, but attention is directed to it as an important contribution to the literature of chain reactions.

Permanent Magnets

THE economic utilization of modern permanent magnets was the subject of a paper read by D. J. Desmond on February 16 before the Institution of Electrical Engineers. In this paper the author first establishes the equation to the demagnetization curve and then proceeds to discuss the uses of permanent magnets in typical pieces of apparatus. The working of the magnet under these various conditions is considered and the useful part of the magnetic energy is calculated, thus introducing a new method by making use of the unit permeance of a circuit. Certain approximations are made in this calculation and the limitations of the simple theory are then discussed. A method is given of designing a magnet in terms of the constants of the iron circuit. Figures are provided for two modern alloys in common use, and curves are plotted for the complete solution to all design problems. The interchangeability of these two alloys is discussed, and it is pointed out that not all the additional energy of the anisotropic alloy can usefully be employed. This is due to the larger curve factor, which reduces the recovery when a demagnetizing force is removed. It is shown that the $(BH)_{\max}$ value is not the criterion of usefulness of a magnet, except in the simplest case, nor is it necessary for the magnet to work at the $(BH)_{\max}$ point.

Radioactivity of Sedimentary Rocks

A RAPID method for the determination of uranium, thorium and potassium in rocks (based on the use of β -ray counters calibrated with radioactive standards) has been devised by R. F. Beers and C. Goodman, and applied to more than three hundred samples of various types of sediments from oil wells drilled through Paleozoic formations (*Bull. Geol. Soc. America*, 55, 1229, 1944). The results indicate that the principal loci of radioactivity are in (a) heavy minerals in sands and sandstones, (b) potash-rich sediments, and (c) sediments of colloidal deposition. It is shown that organic black shales show excellent correlation of uranium content, organic matter, abundance of grades of colloidal size, and a high ratio of thorium to uranium. All these correlations have an important bearing on genetic relationships in petroleum source beds. Goodman's prediction (*J. App. Phys.*, 13, 276, 1942) that petroleum source beds should have high thorium-uranium values has been supported. Evidence is recorded showing that in primary igneous rocks and organic black shales, potassium and uranium increase directly with one another. It is also established that rocks of high uranium and thorium content possess high emanating power, a feature which complicates the technique of the radioactivity measurements.

THE DISPLACEMENT METHOD OF WEIGHING LIVING AQUATIC ORGANISMS

By ASHLEY G. LOWNDES

IN 1927 a method was devised by which living aquatic organisms can be weighed without removing them from their environment. Two accounts of the method were published in 1938^{1,2}, but a much fuller account of the technique was published in 1942³ and 1943⁴. In outline the method is very simple since, in the case of a marine animal such as a prawn, it consists of placing it in a suitable density bottle which is otherwise full of sea water and weighing the whole. The exact volume of the bottle and the density of the sea water are readily obtainable, and it is then only necessary to know the exact volume of the prawn to ascertain its weight.

The exact volume of the prawn can also be obtained. The bottle is filled with sea water and the contents poured into excess of silver nitrate, and the silver halide weighed. The experiment is then repeated, but with the prawn in the bottle. From the weights of the two lots of halide, the volume of the prawn is obtained with considerable accuracy. Alternatively, the sea water can be poured into a standard flask and an aliquot part titrated. The prawn itself is retained by some suitable means and rinsed with a suitable non-halide solution which is at the same time isotonic with the sea water.

In actual practice the technical details are rather laborious, but the method lends itself to extreme accuracy. It has been reviewed in *Nature*⁵; but since the accuracy of the results obtained caused at one time considerable criticism, a full account of the method was submitted to the Director of the National Physical Laboratory, to whom I wish to extend my sincere thanks, and a report obtained from Mr. Verney Stott, who stated that errors should occur in the fourth place of decimals *only*.

Actually the limiting factor does not lie in the technique, but in the accuracy with which it is possible to obtain the density of the sea water in circulation in the aquarium tanks. This could be filtered and the dissolved air driven off by boiling, but the resulting sea water would then no longer represent the real external environment of the organisms.

The method is applicable to freshwater organisms but a rather different technique is necessary. Large crabs and lobsters weighing several pounds have been tackled, as well as nursehounds up to 4 ft. in length. At the other end of the scale, a single specimen of the second larva of the common lobster has been weighed, which amounted to 0.0074 gm., and by taking a large number of specimens such as are obtained from an artificial fertilization of sea-urchins, it is possible to find the density of the various embryonic stages.

Some Applications of the Method. First and foremost, there is the question of analysis, for clearly you can only analyse correctly provided you can first weigh correctly. Usually all analysis has been carried out on air-dried or oven-dried material, and hence many of the results are open to considerable criticism.

Then there is the relationship between the organism and its external environment, or what is known as the *sinking factor*. The impression has been given by some biologists that a marine organism, since it lives in an environment with a density of about 1.03, is

unaffected by gravity. Thus to quote one instance: "Fishes, by *evading gravity*, increase their range of magnitude both above and below that of terrestrial animals"⁶. True, on a *priori* grounds, we might expect that those organisms with the lowest sinking factor would be the most consistent in their swimming or floating habits, but direct measurement shows that no such simple direct relationship exists.

A consideration of density would have prevented many of the existing fallacies from permeating current biological literature to the extent to which they do at present. Thus for years it has been stated and accepted that the common jelly-fish comprises 99 per cent water. This is, of course, clearly impossible since it implies that the remaining 0.2 per cent would have to have a density of 16 or so.

Again, Stokes's Law has been used for trying to find the density of such diverse material as the bit of a squashed egg of a sea-urchin, and a narcotized Calanoid or a Cladoceran the surface of which is practically covered with spines, yet some of the first conditions for the application of the law are that the particles must be smooth and spherical, and the radius known or at least measurable.

If, on the other hand, we can weigh accurately a living Calanoid and obtain its density, and then find its rate of sinking through unadulterated sea water, we should be able to get a close approximation to the amount of energy needed to keep such an animal near the surface, or possibly the energy expended during rapid swimming movements.

Finally, there is the question of the resolution of forces about the centre of gravity. If the tissues are more or less homogeneous and arranged more or less symmetrically about a point, that point will constitute the centre of gravity of the organism. But, if such an organism is situated in an external environment the density of which is equal to the density of the whole organism, then there can be no *functional* centre of gravity. This seldom occurs in actual fact but many of the teleost fishes with large central swim-bladders approximate closely to it.

Embryology. Embryologists still talk about the high density of 'yolk' and its effect on segmentation. The density of the yolk of the hen's egg is, however, 1.025, while that of the dogfish egg is 1.1. Thus the density of the yolk in the one far exceeds the density of protoplasm, while in the other it is considerably below it, yet in both cases the segmentation is meroblastic and this is always attributed to the presence of the yolk. Alternatively, the ova of *Echinus* are small and have a low density and very little yolk, while the ova of the spider crab *Mancusquado* are very much larger and have a density greater than 1.1, yet in both cases the segmentation is holoblastic and equal, or at any rate it appears to be so.

Evolution. The real interest of the method, however, lies in the light that it may possibly throw on the primary cause of evolution. Almost ever since the publication of the "Origin of Species", most biologists seem to have regarded evolution as exclusively a biological process, with most disastrous effects on the study of biology itself. It is true that Herbert Spencer was careful to describe the origin of organisms and the increase in complexity of tissues as *organic evolution*, but his example has certainly not been followed recently. Moreover, the still worse error of regarding natural selection or the struggle for existence between individuals as one of the primary causes of organic evolution is still rampant. Though natural selection has now been cleared of much of

uperfluous material and constitutes a sound and mathematical concept, chiefly owing to the work of A. Fisher, yet, whatever the importance of the process within organic evolution itself, it was not a primary cause

Clearly cosmic or inorganic evolution must have been at work long before organic evolution started, and the primary cause of organic evolution is to be sought for within the cause of inorganic evolution. It is true that the origin of the universe or even of the solar system is still a much debated question, but no scientific theory yet put forward disregards the law of gravitation, and most include either the concept of maximum entropy or of thermodynamic potential. Clearly none of these concepts is applicable to organisms or tissues of unknown weight or density. The very elementary theoretical outcome of this view may be cited briefly. Without disregarding the fact that there may be no real distinction between the living and non-living in the initial stages, we are justified in assuming that the first *free-swimming* organisms consisted of protoplasm and existed near the surface of water. Since, however, the density of protoplasm must always exceed that of the water constituting its external environment, the first struggle for existence must have been influenced by gravity and not primarily by competition between individuals. It would appear, therefore, that the accurate determination of weight and density is of fundamental importance for an accurate study of aquatic organisms.

Nature, 141, 289 (1938)

Lowndes, *Proc Linn Soc., London*, 150, Pt. 2 (1937-38)

Lowndes, *J. Mar. Biol. Assoc.*, 25, No. 3, 555 (1942)

Lowndes, *Proc Zool Soc. London*, A, 113, 28 (1943)

Nature, 150, 695 (1942)

Thompson, Sir D'Arcy, "Growth and Form", 67 (Cambridge, 1942)

THE HORSE-CHESTNUT TREE (*AESCULUS HIPPOCASTANUM*)

By ALEXANDER L. HOWARD

"Oh! there the chestnuts, summer through,
Beside the river make for you
A tunnel of green gloom, and sleep
Deeply above"

RUPERT BROOKE

THE horse-chestnut tree is not indigenous to Great Britain but was introduced in the middle of the sixteenth century, there is some doubt as to its origin, but the general opinion is that it was a native of the Balkan mountains, or perhaps that it was introduced there from Iran, northern India or Tibet. Gerrard speaks of the first tree being heard of in 1579, and from this date it became generally planted throughout western Europe, especially in Ireland, Sicily and Corsica. In the most favourable circumstances it may attain a height of about 20 ft, with a girth of 18 ft, and in Ireland Elwes mentions a tree at Woodstock, Kilkenny, which was 3 ft in height and 18 ft. 1 in in girth. The tree is well known to men, women and children, the former principally for the beauty of its flowers in the early summer, and the latter who wait impatiently for the autumn when they can throw sticks at the branches to dislodge the fruits which contain the seeds or "conkers".

The horse-chestnut (*Aesculus hippocastanum*) is often mistakenly confused with the sweet-chestnut (*Castanea sativa*) to which it is not related either in fashion or family. C. A. Johns says that the origin of the name is in doubt. "The name *Aesculus*, from *esca*, food, was applied originally to a species of Oak, which, according to Pliny, was highly prized for its acorns, but how it came to be transferred to the Horse Chestnut is very uncertain, perhaps, as Loudon suggests, it was given ironically because its nuts, which are unfit for food, bear a great resemblance externally to those of the Spanish Chestnut *Hippocastanum* is a translation of its modern name, which was given 'from its curing horses broken-winded and other cattle of coughs'" (Evelyn)

Pliny, according to the translation by Dr Philemon Holland, does not mention horse-chestnut, but he describes what he calls *Esculus*, terming it oak. This does not apply to the oak but fits the horse-chestnut. In his time the mountains of Greece abounded with these trees, and it is thought that this was its native habitat. It was introduced and freely planted in Sardinia, Sicily, and Corsica, and Pliny refers to what he calls "the Sardinian nut". Whether by this name he was speaking of the sweet-chestnut or the horse-chestnut is not clear, but it is probable that he was referring to the sweet-chestnut. It seems evident that in his time the tree was valued for its fruit but not for its timber. He says

"The best mast (nut) and the biggest is the acorne growing upon the common Oke, next to it is that of the *Esculus*, as for that of the Robur it is but small. The cernus carrieth a mast unpleasant to the eye, and rough to be handled, for clad it is with a cup beset with sharpe prick like to the Chestnut tree

We entitle Chestnuts also by the name of Nuts, although indeed they are more aptly to be called a kind of Mast. This fruit whatever it be, is enclosed within a huske, and the same defended and armed all over with a ramper and palisade (as it were) of sharpe pricks like the skin of an Urchin, whereas the Acorne and other Mast is but half covered, and that defence in them is begun only. And certes, a wonderful matter it is, that we set little store by this fruit, which Nature is so careful to hide and defend. Under one of these husks ye shall find sometime three Chestnuts, and those having certain tough pills or shells very pliable. But the skin or filme within, and which is next to the bodie or substance of the fruit, unless it bee pulled off and taken away, marroth the tast of it, like as it doth also in other nut kernels. Chestnuts, if they be rosted, are better and more pleasant meat than otherwise. They use also to grind them to meale, and thereof is made a kind of bread that poore women for hunger will eat. The first Chestnuts were knowne to grow about Sardis and from thence were brought and therefore the Greeks call them Sardinian nuts."

It is impossible to decide for certain whether he was speaking of the sweet-chestnut or the horse-chestnut, but it seems probable that although his description would apply equally to the nuts of either tree, he must have been referring to the former.

At the time of John Evelyn it became fashionable to plant the horse-chestnut in avenues, and many famous examples dating from this time can still be seen in different parts of the British Isles—as well as on the Continent, in private and public parks and gardens. In this way the chestnut shows its full beauty and dignity at all seasons of the year, but specially when its candle-like flowers are in full bloom. One of the most famous chestnut avenues in England is at Bushey Park, Hampton Court, which is visited year by year by many people on Chestnut Sunday.

However it is situated, the horse-chestnut is the

first of our trees to clothe itself with green leaves, which are different in shape from those of our other forest trees, having five to seven leaflets, 4-9 in. long, and brilliant light green in early spring, deepening to a heavy darker shade and turning to golden yellow before they fall in early autumn.

The bark is smooth of a greenish-brown colour, and the crown generally becomes pyramidal in shape. Sometimes the branches droop, and in cases dig into the ground all round the base of the tree, whence they take root and spring up again, often attaining a much increased girth in the upward growth than that proceeding from the tree in the downward bend. A remarkable tree of this habit is in vigorous health at Hawkhurst Moor, with a height of about 90 ft., and covering the ground to a circumference of 285 ft.

The yellow horse-chestnut (*Aesculus octandra*) was first introduced into England in 1764. The red horse-chestnut (*Ae. carnea*) was, according to Elwes, first introduced from Germany in 1818. Both may be seen in almost every garden and park, especially around London and other cities. Neither of these trees attains the dimensions of the common horse-chestnut (*Ae. hippocastanum*).

Ae. pavia, a shrub bearing a red flower, is referred to by Elwes, who says "it closely resembles *Aesculus octandra*" and supposed to have produced with *Ae. hippocastanum* the hybrid *Ae. carnea*. Loudon describes this as "The Pavia, or smooth-fruited Horse-chestnut tree" and also mentions *P. rubra*, but the whole subject is so confused that it is difficult, if not impossible, to state accurately the botanical variations.

Both the horse-chestnut and the sweet-chestnut, for some unexplained reason, are subject to spiral growth in the British Isles. During the War of 1914-18, the subject of spiral growth came very much to the fore, as apparently sitka spruce (*Picea sitchensis*) imported from British Columbia was found to carry this defect more than any other tree for which there was an equal demand. Inquiry into the subject brought suggestions, one of which was that it was a hereditary feature. Although this may be possible, I am more inclined to think that spiral growth is caused by the situation of the tree and its relation to the sun and wind. In Hyde Park, in the triangular piece of ground between the Magazine and the Epstein statue, by the Serpentine, there are twenty-four horse-chestnut trees, all but two of which show spiral growth, a number proportionately much greater than in any other part of the Park. This site must be subject to varying winds from different quarters, while the rays of the sun may influence the direction of the growth. At the same time, it is strange that one particular tree should be subject to more spiral growth than another—a subject well worth inquiry.

About 1920, shipments arrived in London, and probably Paris, Hamburg, and Rotterdam, of Japanese horse-chestnut (*Aesculus turbinata*—the Japanese name for which is 'Tochi-noki'). These shipments consisted of large-sized slabs, or flitches and planks. The wood was similar in colour and texture to that grown in England, but mainly consisted of highly figured wood, rich in roe and splash-mottle, some bright and clean, while other was streaked with black marks—denoting incipient decay. All this timber was equally sound and good, while that streaked with black was particularly decorative, and was greatly in demand for art furniture in which it realized high values.

Speaking of the British variety, Elwes mistakenly says:

"The wood of the Horse Chestnut is one of the poorest and least valuable we have, on account of its softness and want of strength and durability. Though it has a fine close and even grain, white or yellowish-white colour, and is not liable to twist or warp so much as most woods, it does not cut cleanly."

Elwes cannot have known the many purposes for which chestnut has been used.

Quoting from "Timbers of the World":

"If the tree be cut down early in winter, promptly sawn into boards, etc., and carefully stored, wood of extreme whiteness may be obtained. If, however, the trunks are felled later in winter, or are allowed to lie for any length of time the wood assumes a yellowish-brown tint. It is of moderate weight, soft fine-grained, but perishable, used for making soap-bowls, brush-backs, in turnery, and occasionally for veneers. Even with the development which have occurred since the war (1914-1918), supplies of horse chestnut are not sufficiently valued or appreciated. In Southern Europe it is said to have been used for fruit-storing shelves, the porous nature of the wood absorbing the moisture from the fruit, the preservation of which is thereby assisted."

Besides its use for gunpowder and charcoal, this timber is most valuable for furniture and works of decorative art, for which purpose it has been by far too little appreciated.

STATISTICS IN GOVERNMENT DEPARTMENTS

A MEMORANDUM on the Post-War Organization of Statistics in Government Departments, which has been prepared by the Institution of Professional Civil Servants for submission to the Treasury, draws largely on material in the Memorandum on Official Statistics issued by the Royal Statistical Society with the recommendations of which the Institution to a considerable extent agrees, apart from certain proposals with regard to the structure of the statistics service and the status of its officers. The Institution's own proposals are set out under five headings. First, with regard to the functions of a statistical service, it is considered that the work of the statistical service should be an integral part of the administration, including such public functions as the collection, presentation and publication of a continuous series of statistics relating to the economic and social condition of the nation, the interpretation and enlargement for publication of material already covered in part by existing statistics, together with explorations into fields not hitherto covered, so as to provide industry and trade with information which by its nature can only be collected through the agency of the Government, and research into the statistical aspects of social questions. One internal function should be provision of the pre-requisites of policy formation, and the memorandum claims that the statistician, in providing material on the quantitative aspects of a problem, should be called upon to play his part in deciding how things planned for the future are to be attained.

Next, with regard to grades, salary, promotion and superannuation of statistical staff, the Institution urges that there should be only two classes of statistician, a principal statistician class, with career value comparable with that of the administrative class of the Civil Service, and an executive

statistician class, working normally under the direction of members of the principal class and with career value comparable with that of the executive class. Superannuation should be provided on terms comparable with those available to the rest of the Civil Service, and in addition to facilities for post-graduate training and for opportunities for widening experience by seconding for limited periods to statistical posts outside the Government service, the institution emphasizes the desirability of transfer of statisticians to administrative posts, as well as of transfer between departments and with the Central Statistical Office. The views of the Royal Statistical Society on the value of mechanical aids are endorsed.

With regard to the qualifications and recruitment of statistical staff, the memorandum welcomes the scheme to set up a certificate and diploma in statistics proposed by the Royal Statistical Society, and although the syllabus appears to demand a rather higher standard of mathematical statistics than would in general be required for entry into Government service, possession of the diploma is suggested as an alternative qualification to a university degree with first- or second-class honours in the relevant subject, including statistics, for eligibility for appointment to the principal statistician class. For the executive statistician class, the higher school certificate with distinction in statistics, or the Royal Statistical Society's certificate is suggested. A central recruiting body for statistical officers should certify the candidate's eligibility for appointment, and appointments should be made by a selection board from eligible candidates on the basis of interview, the Board including representatives of the central recruiting body, the Establishment Department, the Institution of Professional Civil Servants and the head of the statistical section of the department concerned. These conditions are not intended to apply to existing members of the Government statistical service or to persons who have done outstanding statistical work elsewhere.

With regard to the transition to the post-war period, sufficient of the existing personnel should be retained to ensure the immediate establishment of a comprehensive statistical service envisaged, and an immediate decision on the questions of post-war organization, recruitment, salaries and promotion is a matter of urgency. With regard to statistical material, it is important to ensure that existing collections and compilations are preserved, and pressure from commercial firms in favour of discontinuing the making of returns necessary for statistical continuity should be resisted. Statistical branches should collect basic data from the source.

With regard to the relation between statistical branches and the Central Statistical Office, the institution examined the suggestion for a Government statisticians' department, but decided that the type of organization recommended by the Royal Statistical Society would give a more efficient statistical service, and accepted the recommendations of the Society's memorandum with regard to the functions of the Central Statistical Office. That Office should maintain a central library and records office staffed by people competent to give advice. It should maintain a full record of confidential statistics compiled by all the various Government departments, and available to authorized persons in the Government service. The library would also be the depository for statistical records of Government departments which close down.

TOXIC SPRAY SUBSTANCES AND PLANT GROWTH

ONE result of the continued use of sprays containing toxic inorganic constituents may be the accumulation in the soil of substances deleterious to plant growth. Of practical interest, therefore, are experiments described by N. F. Childers¹, who found that the presence of sodium arsenate in the soil had a stimulating effect on 'Delicious' apple seedlings when the concentration was not more than 20 parts per million. Between 60 and 160 parts per million, toxic effects were apparent, and if the concentration was more than 100 parts per million the seedlings died. Equivalent amounts of arsenic in the form of lead arsenate were less toxic, and lead chloride even at 160 parts per million exerted no deleterious effect. More carefully controlled experiments with plants in gravel culture showed that 20 parts of arsenic per million of culture solution stimulated the growth of apples and of rye but depressed the growth of grapes. Both apples and grapes were tolerant of 200 parts of lead per million of solution and both showed a progressive decrease in growth as the copper content of the solution rose from 10 to 30 parts per million.

Different fruits show differing tolerance of arsenic, but R. C. Linder² reports that peaches are especially susceptible, and if the arsenic content of the leaves exceeds 2 parts per million of dry matter, marginal and interveinal burning and shot-holing of the leaves occur, with, in severe cases, defoliation. Apricots show a similar effect, but plums, pears and apples are more resistant, and plum foliage containing as much as 13 parts of arsenic per million of dry matter appeared healthy.

¹ *Proc. Amer. Soc. Hort. Sci.*, **38**, 157 (1941).

² *Proc. Amer. Soc. Hort. Sci.*, **42**, 275 (1943).

FORTHCOMING EVENTS

Saturday, April 28

NUTRITION SOCIETY (joint meeting with the BIOCHEMICAL SOCIETY) (at the London School of Hygiene, Keppel Street, Gower Street, London, W.C.1), at 11 a.m.—Discussion on "The Vitamin-B Complex".

INSTITUTE OF PHYSICS (ELECTRONICS GROUP) (joint meeting with the MIDLAND BRANCH) (at the University, Edmund Street, Birmingham), at 2.30 p.m.—Dr. H. Kuhn "Atomic and Molecular Beams".

Sunday, April 29

ASSOCIATION OF AUSTRIAN ENGINEERS, CHEMISTS AND SCIENTIFIC WORKERS IN GREAT BRITAIN (at the Austrian Centre, 69 Eton Avenue, Hampstead, London, N.W.3), at 11.30 a.m.—Dr. B. Burzryn "On Recent Applications of Thermo-setting Resins on Paper and Textiles".

Monday, April 30

ROYAL SOCIETY OF ARTS (at John Adam Street, Adelphi, London, W.C.2), at 1.45 p.m.—Sir Frank Smith, G.C.B., F.R.S. "Chemicals from Petroleum" (Cantor Lectures, 3).

NORTH-EAST COAST INSTITUTION OF ENGINEERS AND SHIPBUILDERS (Mining Institute, Newcastle-upon-Tyne), at 6 p.m.—Sir Amos Ayre, K.B.E. "An Approximate and Simple Formula concerning Four-Bladed Propellers of Single-Screw Cargo Ships".

Tuesday, May 1

SHEFFIELD METALLURGICAL ASSOCIATION (at 198 West Street, Sheffield 1), at 6.30 p.m.—Dr. N. P. Ingles "Some Views on Materials of Construction and their Fabrication, in the Light of Present Research and Likely Requirements".

INSTITUTION OF ELECTRICAL ENGINEERS (LONDON STUDENTS' SECTION) (at Savoy Place, Victoria Embankment, London, W.C.2), at 7 p.m.—Discussion on the Report on "Education and Training for Engineers" and a subsequent Report on "Part-time Further Education".

Wednesday, May 2

SOCIETY OF PUBLIC ANALYSTS AND OTHER ANALYTICAL CHEMISTS (at the Chemical Society, Burlington House, Piccadilly, London, W.1), at 5 p.m.—Mr. G. W. Osborn "A Rapid and Simple Method for the Determination of Calcium in presence of Strontium and Barium", Mr. W. B. Wragge "Lead Printing" of Ferrous and Non-Ferrous

Metals", Mr E Collins "Reaction of Diazotised *p*-Nitraniline with Phenols, Detection of Tricresyl Phosphate in Edible Oil" Dr A J Henry "A Simple Apparatus for Handling Standard Solutions of Bromine in Potassium Bromide"

INSTITUTION OF ELECTRICAL ENGINEERS (RADIO SECTION) (at Savoy Place, Victoria Embankment, London, W C 2), at 5 30 p m — Mr N Lea "Notes on the Stabilities of L C Oscillators"

Thursday, May 3

SOCIETY OF PUBLIC ANALYSTS AND OTHER ANALYTICAL CHEMISTS (PHYSICAL METHODS GROUP) (at the Chemical Society, Burlington House, Piccadilly, London, W 1), at 3 p m — Dr H W Thompson "Infra-red Spectrography in relation to Chemical Analysis"

THE BEDSON CLUB (King's College, Newcastle-upon-Tyne, 2), at 5 30 p m — Dr U R Evans "The Prevention of Metallic Corrosion, by means of Soluble Inhibitors" (Bedson Lecture)

INSTITUTION OF ELECTRICAL ENGINEERS (INSTALLATIONS SECTION) (at Savoy Place, Victoria Embankment, London, W C 2), at 5 30 p m — Mr R T Lythall "Excess-Current Protection by H R C Fuses on Medium-Voltage Circuits", Mr A G Shreve and Mr P J Shipton "Excess-Current Protection by Overcurrent Relays on Medium-Voltage Circuits"

Friday, May 4

ROYAL INSTITUTION (at 21 Albemarle Street, London, W 1), at 5 p m — Sir William Halcrow "Tidal Power"

INSTITUTION OF ELECTRICAL ENGINEERS (MEASUREMENTS SECTION), (at Savoy Place, Victoria Embankment, London, W C 2), at 5 30 p m — Mr G F Shotton "Meter and Instrument Jewels and Pivots"

GEOLOGISTS' ASSOCIATION (at the Geological Society of London, Burlington House, Piccadilly, London, W 1), at 6 p m — H G Dines "Mining Geology of Cornwall and Devon"

Saturday, May 5

AMATEUR ENTOMOLOGISTS' SOCIETY (at Buckingham Gate Central Schools, Wilfred Street, Victoria, London, S W 1), at 2 p m — Exhibition of Entomological Apparatus and Technique

APPOINTMENTS VACANT

APPLICATIONS are invited for the following appointments on or before the dates mentioned

BOROUGH ANALYST—The Town Clerk, Town Clerk's Office, Civic Centre, Southampton (endorsed 'Appointment of Borough Analyst') (May 4)

HISTOLOGICAL TECHNICIAN FOR THE DEPARTMENT OF ANATOMY—The Secretary and Registrar, The University, Bristol (May 4)

SOIL CHEMIST—The Secretary, Edinburgh and East of Scotland College of Agriculture, 13 George Square, Edinburgh 8 (May 7)

RESEARCH PHYSICIST for advanced experimental work in connexion with Electron Tube Research and Development, and an Officer for Microwave Crystal Development work on the staff of the Division of Radiophysics, Sydney—The Secretary, Australian Scientific Research Liaison Office, Australia House, Strand, London, W C 2 (May 11)

LECTURESHIP IN MECHANICAL ENGINEERING—The Principal, Heriot-Watt College, Edinburgh (May 14)

ASSISTANT INSPECTOR (male) OF FISHERIES in the Department of Agriculture—The Secretary, 45 Upper O'Connell, Street, Dublin (May 18)

ASSISTANT IN THE BURSAR'S OFFICE—The Bursar, Bedford College, Regent's Park, London, N W 1

ASSISTANT PHYSICIST to the Deep X-Ray Therapy and Radium Centre—Dr H Canwarden, Medical Superintendent, Warren Road Hospital, Guildford, Surrey

LECTURER IN BACTERIOLOGY to students preparing for the National Diploma in Dairying—The Principal, Studley Agricultural College, Studley, Warwickshire

LABORATORY STEWARD FOR PHYSIOLOGICAL LABORATORY—St Mary's Hospital Medical School, London, W 2

REPORTS and other PUBLICATIONS

(not included in the monthly Books Supplement)

Great Britain and Ireland

Historic St Andrews and its University By Prof John Read Second edition Pp 30+8 plates (St Andrews W C Henderson and Co, Ltd, 1945) 1s 6d [213]

University College of Wales, Aberystwyth Welsh Plant Breeding Station Leaflet Series S, No 5 Aberystwyth-bred Varieties of Oats and Pure Line Selections of Hen Gymro Wheat By E T Jones Pp 11+10 (Aberystwyth Welsh Plant Breeding Station, 1945) 1s [213]

Science in Peace an Account of the Conference held at the Caxton Hall, 17th 18th February 1945. Pp. 16 (London Association of Scientific Workers, 1945) 3d [223]

Scotland, a Wealthy Country By Dr Arche Lamont Pp 64 (Glasgow Scottish Secretariat, Ltd, 1945) 1s [223]

Research Reports of the British Non-Ferrous Metals Research Association Association Series, No 657 Damping Capacity, a General Survey of Existing Information By Prof F C Thompson Pp 11+38 3s 6d Association Series, No 661 Shrinkage and Gas Effects in the Casting of Non-Ferrous Metals and Alloys By W A Baker Pp 44 7s 6d (London British Non-Ferrous Metals Research Association, 1944) [223]

Imperial Institute Annual Report, 1944, by the Director, Sir Harry Lindsay, to the Board of Governors Pp 67 (London Imperial Institute, 1945) [223]

Proceedings of the Royal Irish Academy Vol 50, Section A, No 6 Quaternary Centenary Celebration By R I Best, J L Synge, G D Birkhoff, A J McConnell, E T Whittaker, A W Conway, F D Murnaghan and J R Colthurst Pp 69-122+2 plates 3s Vol 50 Section A, No 7 The Spectrum of Manganese Hydride MnH, 2 The Structure of the A'' and X^2 States By T E Nevill Pp 123-138 1s Vol 50, Section A, No 8 Note on the Influence of Damping on the Compton Scattering By Sheila C Power Pp 139-142 n p Vol 50, Section B, No 5 The Pollnagollum Cave, Co Clare By J C Coleman and N J Dunnington Pp 105 132+plates 15-17 2s 6d Vol 50, Section B, No 6 The Glacial Drifts of the District around Enniskerry, Co Wicklow By A Farrington Pp 133-151 +plate 1E 1s 6d Vol 50, Section B, No 7 The Mechanical Anatomy of the Acromio-Clavicular Joint of Man By M A MacConnell Pp 159-166 1s Vol 50, Section B, No 8 The Distribution of Irish Char (*Saccharinus* spp) By Arthur E J Went Pp 167-190 1s (Dublin Hodges, Figgis and Co Ltd, London Williams and Norgate, Ltd, 1945) [228]

Ministry of Agriculture and Fisheries Bulletin No 129 Cereals Diseases By W C Moore Pp 11+42+8 plates (London H M Stationery Office, 1945) 1s net [228]

Ministry of Fuel and Power Durham Coalfield Regional Survey Report (Northern 'B' Region) Pp 48 (London H M Stationery Office, 1945) 1s net [228]

Ministry of Fuel and Power Coal Mining Report of the Technical Advisory Committee (Cmd 6610) Pp ix+150 (London H M Stationery Office, 1945) 1s net [228]

Smokeless Zones Pp 12 (London National Smoke Abatement Society, 1945) 3d [228]

Scientific Proceedings of the Royal Dublin Society Vol 24 (N S) No 1 Irish Previously Spawned Salmon By Arthur E J Went Pp 8 (Dublin Hodges, Figgis and Co, Ltd, London Williams and Norgate, Ltd, 1945) 1s [228]

Other Countries

A Contribution to the Prehistory of Mocambique, by Prof C van Riet Lowe, and Report on Material from Kitchen-Middens near the Mouth of the Limpopo River, by L H Wells Pp 16 (Johannesburg Prof C van Riet Lowe, University of the Witwatersrand, 1944) [241]

U S Department of Agriculture Circular No 708 The Citrus Thrips Measures for its Control, and their Effect on other Citrus Pests By E A McGregor Pp 12 Miscellaneous Publication No 550 Family Food Consumption in the United States, Spring 1942 Pp vi+157 20 cents (Washington, D C Government Printing Office, 1944) [241]

The Demonstration of Euclid's Fifth Axiom By George Pincus Pp 6 (San Jose, Calif The Author, 552 North 4th Street, 1945) [241]

Indian Forest Leaflet No 53 Indigenous Charcoal Kilns By K L Budhuria and A C Dey Pp 11+13 6 annas, 7d Indian Forest Leaflet No 54 Brick-Walled Charcoal Kilns Pp 11+10 6 annas, 7d Indian Forest Leaflet No 55 Metal Charcoal Kilns Pp 11+5 6 annas, 7d (Delhra Dun Forest Research Institute, 1943) [241]

U S Department of Agriculture Technical Bulletin No 880 Mineral Oils, Alone or Combined with Insecticides, for Control of Earworms in Sweet Corn By G W Barber Pp 83 (Washington D C Government Printing Office, 1944) 15 cents [241]

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SCIENCE AND PROGRESS IN INDIA

THE extent to which the welfare, prosperity and, indeed, the very existence of a nation depend on scientific research and on the application of scientific knowledge has been brought home to everyone during the present War. Their supreme importance was fortunately realized in time in Great Britain, and between 1939 and 1941 arrangements were made between the United Kingdom, the Dominions and the United States for close co-operation in scientific research and the full interchange of scientific and technical information in all matters connected with the War. As a consequence, there are now scientific missions or representatives of the Dominions and the United States in London. The United Kingdom has a scientific representative at Ottawa, and there is at Washington a British Central Scientific Office that acts jointly for the United Kingdom and the Dominions in maintaining a scientific liaison with the United States. In addition, many special missions have been continually at work in all these countries. An attempt in 1941 to bring India into this picture was, however, unfortunately unsuccessful, as the need of this scientific and industrial collaboration was not then recognized in that country.

To help the continuance of such collaboration after the War, when problems of reconstruction and development for the betterment of the life of the people of the world will arise, the Royal Society in 1941 took the opportunity of the presence in London of scientific representatives of the Dominions to set up a British Commonwealth Science Committee to consider how collaboration in scientific matters throughout the Commonwealth and Empire could be made closer, and in the absence of any Indian men of science in London, the secretary of the Education Department at India House attended. One result of the report of this Committee* is that it is now proposed to call after the War an Imperial Scientific Conference to which scientific representatives of the United Kingdom, India, the Dominions and the Colonies will be invited.

When the Government of India became aware of these activities and of the feeling among British men of science that their Indian colleagues should be taking part, an invitation was sent by the Viceroy, through the Secretary of State for India, to the president of the Royal Society, for Prof. A V Hill to go to India as the representative of the Society, in order to discuss the organization of scientific and industrial research as a part of the Indian post-war reconstruction plan, and also current research problems, with visits to universities and other research centres. The Royal Society agreed to the proposal, and Prof Hill spent from November 1943 to April 1944 in a tour of Indian centres of work connected with science, medicine and technology.

The results of his discussions, visits and contacts with Indian science, industry, medicine and official circles have now been published in a document of

* British Commonwealth Science Committee. (Royal Society, Burlington House, London, W 1 1943)

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great importance, entitled "Scientific Research in India". A digest of the report, section by section, appears elsewhere in this issue of *Nature* (p. 532). This document, of which the preface is dated August 14, 1944, is all the more important because everywhere he went Prof Hill was welcomed with the utmost cordiality and given the freest access to information as a representative of the Royal Society and of British science. As a result of his tour, Prof Hill is convinced that there is no difficulty in the way of full and friendly co-operation between India and Great Britain in the scientific, medical and technical fields. Everywhere the emphatic opinion was expressed that one of the most important needs to-day of Indian science, medicine and technology is better facilities to send the ablest young Indians abroad, particularly to the United Kingdom, for advanced and postgraduate study, for work experience, and for training in research.

In order to understand the implications of this report, it is desirable to know something of the history of the development of the present scientific background in India. This development has followed two parallel lines, official and non-official, each beginning towards the end of the eighteenth century in Calcutta, which was the capital city of the East India Company and later (from 1858) of the Government of India under the Crown, until the removal of the capital to New Delhi in December 1911 as a result of the visit of the King-Emperor to India.

The official line began with the appointment of such officials as the Superintendent of the Botanical Gardens, Sibpur (1788), the Assay Master at the Calcutta Mint (1792), and a Government geologist (1818), and the establishment of the Trigonometrical Survey (1800), and of several astronomical and meteorological observatories (1792-1824), leading ultimately to the formation of the modern survey departments, the Geological Survey (1851), the Meteorological (1875), Survey of India (1878), and the Botanical Survey (1889). This was followed by provision for the applied sciences, mainly in the form of research institutes, for example, agriculture (1885-1903), veterinary (1890-1925), forests (1906), medical (1906), and public health and hygiene (1934). Another phase of official provision has been through the institution of universities, in Bombay, Calcutta and Madras, all dating from 1857, the year of outbreak of the Mutiny, the Punjab (1882), and Allahabad (1887), with several others founded during the present century. The Indian Institute of Science at Bangalore may be conveniently mentioned here, though it owes its inception to the munificence of the Tata family, supplemented by Government aid. Private bequests have, of course, also played a part in the development of the universities of India.

The non-official line of development began with the foundation of the Asiatic Society (now the Royal Asiatic Society of Bengal) by Sir William Jones in 1784. From its activities has sprung the larger part of non-official scientific activity in India (including a portion of the development along the official line), not to mention all its own work for literature, history, archaeology and philology. In addition, the Indian

Museum, Calcutta (1866) was based originally on the collections of the Asiatic Society, the official Zoological Survey of India (1916) is a descendant of the zoological section of this Museum. The Asiatic Society must also be regarded as the mother of the Indian Science Congress Association, which held its first meeting in 1914, and, as Prof Hill remarks, the grandmother of the National Institute of Sciences of India, founded by the Indian Science Congress in 1934.

Besides the Royal Asiatic Society, there are now two other academies claiming national scope, namely: (a) the United Provinces Academy of Sciences, founded at Allahabad in 1930, renamed the National Academy of Sciences, India, in 1936, and (b) the Indian Academy of Sciences, founded at Bangalore in 1934.

The growth of scientific activity in India has led also to the formation of a number of specialist all-India societies mainly with their headquarters in Calcutta, for example, mining and geology (1906), mathematics (1907), engineering (1921), botany (1921), chemistry (1924), physics (1934), soil science (1934), and physiology (1934).

From the dates of formation of these non-official academies and specialist societies, it will be realized that during the present century there has been an astonishing efflorescence of science in India as compared with the nineteenth century. This is of course partly due to the growth both in number and stature of the Indian universities, and is best recognized from the wonderful success of the Indian Science Congress, which with the help of a deputation from the British Association, celebrated its twenty-fifth birthday in 1938. This Congress moves annually from centre to centre on the model of the British Association and is now commonly attended by upwards of a thousand members of all grades, this is all the more surprising in view of the sub-continental size of India and the distances that many of the members must travel in order to attend. This annual assembly of scientific workers is also the venue of the annual meetings of most of the all-India scientific societies, as well as of the National Institute of Sciences of India.

The foregoing summary is but a brief outline of the official and non-official provision for science up to the time of Prof Hill's visit. It must be remarked, however, that there has been a marked difference in this century between the rates of growth along the official and the non-official lines. Whereas, on the non-official side, growth once it began was on the whole continuously progressive, the same cannot be said of the official side. It is notorious that official science is subject to severe setbacks when official finances become straitened. During this century there have been two periods of such retrenchment. The first was in 1925, when the Incheape Committee from Great Britain recommended some measure of retrenchment, and the second was in 1931 when, on the recommendation of an Indian Retrenchment Committee, widespread and disastrous curtailment was effected throughout the Government scientific services. The special selection of science for such slaughter showed how little the Government of India understood or valued such work, and it cannot be

nied that in consequence India faced the onset of the present War much worse equipped scientifically than would otherwise have been the case. The change is heart shown by the Government of India in now turning for the help of British science to strengthen Indian science, both academic and applied, is thus all the more to be welcomed. The sad thought is that it has required the impact of war to produce this change.

Although it was not until 1943 that this call for British scientific advice was made, the Government of India had in fact, in 1940, already taken a notable step with the foundation of the Board of Scientific and Industrial Research, which may be regarded as the Indian equivalent of the Department of Scientific and Industrial Research in Britain, and that the Government of India now takes seriously the need for scientific research is shown by the fact that special provision was made in the Budget of 1944 for fuel research and glass research, and for national laboratories for physics, chemistry and metallurgy, so the Government of India gladly accepted the invitation of the British Government, sponsored by the Royal Society, to send a deputation of leading Indian men of science to Great Britain in the autumn of the same year. The members of this deputation are given every privilege and facility to enable them to visit centres of scientific and industrial research in Britain and to make contact with the leading industrial enterprises likely to be helpful to India, and afterwards they went to the United States to make similar contacts there.

The above recital of the past and continuing growth of science in India sounds impressive, so long as India is pictured as one country and its scale is forgotten, but it must be remembered that India is nearly as large as the whole of Europe without the U.S.S.R., and that it has a population approaching 400 millions. Against a background of this magnitude, India's scientific provision is, of course, very small indeed, and there is, as Prof. Hill saw, the need in all directions for great expansion in scientific, medical, and industrial research. This is required for three principal reasons: (1) the improvement of the health of the population, (2) the adequate feeding and employment of this enormous population, which is bound to go on expanding rapidly, (3) the provision of adequate defence forces with modern equipment. Let us consider further the third reason, though only in general terms. Prof. Hill rightly points out that if India wishes to attain national stature, she must be prepared to provide her own defence forces for the future, without reliance on the British Treasury. Thinking of what this may mean has been given by the present War. In the past, when the cost of a portion of the Forces in India has been defrayed by Britain, on the ground that that part was not maintained for purely Indian reasons, the unofficial members of the Indian Legislative Assembly have persistently opposed the provisions of the military portion of the Budget for the maintenance of the garrison. This has appeared as a high proportion of the Central Budget, sometimes as much as 40 per cent, but there are also the budgets of some ten

provincial Governments, none of which pays a penny towards defence. If the totals of these be added to the central total, the provision for defence is seen to be a much smaller proportion of India's total income. This should be emphasized, for in the future, as Prof. Hill sees it, there must be a greatly increased expenditure on defence, so as to enable the equipment of Indian Forces, land, air and sea, to keep abreast of that of other countries on the modern elaborate and costly scale. In addition, to ensure a high quality for this equipment, it will be necessary to maintain an adequately appointed scientific research organization within or in affiliation with the Defence Department, Prof. Hill proposes a War Research Board for this purpose.

How is all this expansion—medical, agricultural and defence—to be financed? Only by a great expansion and improvement of India's basic industry, agriculture, and by a great growth of her existing industries, with the addition of new industries. The Bombay plan of a group of Indian industrialists was proposed for such purposes, and even though its very magnitude may seem visionary, yet some such plan must be implemented, at least in part. The Government of India has accordingly now taken this task in hand, and, following Prof. Hill's visit, has formed a new Department, that of Planning and Development, with, for its first member, Sir Ardeshr Dalal, former managing director of the Tata Iron and Steel Co. and one of the authors of the Bombay plan.

The greatest weakness in the Government of India in respect of scientific activities is that responsibility for it is scattered instead of concentrated. For example, meteorology is under the Department of Posts and Air, geological survey under Labour, the Survey of India, and the Botanical and Zoological Surveys, under Education, Health and Lands, which also controls medical and agricultural research in part. What is needed is that all these scientific activities should be grouped under one member of Government, for which the new Member for Production and Development seems appropriate.

Prof. Hill's recommendation is, therefore, that there should be a Central Organization for Scientific Research working under the Honorable Member for Planning and Development, divided into six research boards: medical, agricultural, industrial, surveys and natural resources, engineering, and war. He makes suggestions for the constitution of these boards, and for each of these branches of activity he proposes a director of research, who would be secretary and principal administrator of his own board, and a member *ex-officio* of each of the other boards. The responsibility of these six directors would be for directing, organizing, initiating and co-ordinating research, on a nation-wide scale, so far as constitutional considerations allowed, each in his respective field.

Between these boards jointly there would be a Research Grants Committee, and a Research Studentships Committee. There would also be a Scientific Consultative Committee to advise the Member for Planning and Development on general policy in relation to research, consisting of the six directors of

research, together with six other distinguished men of science

In advocating this general principle of bringing research into a single organization, Prof Hill points out that this would still leave the Departments of the Government of India free to make their own arrangements for applying the results of research to the practical problems they have to face. From this point of view, Prof Hill regards these other Departments of the Government of India as the 'user' Departments, which, charged with the responsibility of applying the results of research, could set up development or improvement councils, with a liaison with the corresponding research boards. Then, to ensure that development as well as research is co-ordinated at a high level, Prof Hill would set up under the Member for Planning and Development, as an opposite number to the Scientific Consultative Committee, a Development Consultative Council.

If the Government of India acts on Prof Hill's report, as there is every reason to suppose it will, then India will be provided with a co-ordinating and initiating organization for research in the six fundamentally important fields outlined by Prof Hill, an organization that should help materially the improvement of the health of India, the necessary expansion of its agricultural resources, and the expansion of its industries, with a resultant higher level of health and of the employment that is so necessary to produce the greatly increased revenue needed for the general welfare, including the defence of India.

Proposals for the expansion of Indian science and industry cannot, however, be implemented unless men, both in numbers and in quality, are forthcoming to carry them out. India's present educational equipment, including that of the universities, technical colleges, and research institutes, is quite inadequate for the purpose. Consequently, pending a great improvement in educational and technical facilities in India, large numbers of graduate students will have to be sent abroad at Government expense for postgraduate training, both scientific and technical. It is understood that the Government of India is making arrangements for this, and that we may expect a considerable number of such students to arrive in Britain this year. Conversely, it will probably be found necessary, as a temporary measure, for India to import from abroad a considerable number of highly qualified men to help in the reorganization of teaching and training in India. These remarks are made without any reflexion on the professors and other teachers in India, who have done splendid work with the insufficient facilities at their disposal, as must be evident to anyone who contemplates the astonishing success of the Indian Science Congress, of which mention has already been made, or the fact that several Indians have been elected to the fellowship of the Royal Society.

The organization for research proposed by Prof Hill and outlined above will, of course, if adopted, be an official scheme for the co-ordination of scientific research in India, and when carried out it will have to be regarded as a sudden burgeoning on the official

line of development, incidentally co-ordinating, so as possible, activities on the non-official line of growth. There will, however, remain the non-official activities that find their expression in the special scientific societies, in the academies, in the Indian Science Congress Association, and in the National Institute of Sciences of India. These non-official developments must be encouraged by Government and helped financially, while still remaining free. Nevertheless, these non-official activities also need co-ordinating. Prof Hill refers to the fact that Indian men of science have advocated strongly the formation of a National Research Council, and to the four resolutions on this matter passed by the National Institute of Sciences in 1944. Without enumerating these resolutions, it may be said that they were designed to give Indian science and Indian scientists a greater and more appropriate part in national affairs. Prof Hill holds that his proposals are designed to meet the same needs and difficulties as the proposals of the National Institute, and that they will be acceptable to that body. But although Prof Hill's proposals may render unnecessary the formation of a National Research Council formally so named, they do not remove the necessity for a co-ordinating organization for Indian non-official scientific bodies. The National Institute of Sciences of India was, of course, formed for this very purpose, as Prof Hill recognizes, and in fact he expresses the hope that formal recognition may be given to its position by the Government, for example, by the grant of a Royal Charter such as the Royal Society and the British Academy have.

Incidentally, Prof Hill comments on the 'original' name of the National Institute, recognizing, however, that the name chosen was due to a compromise at the time of foundation. The name is, however, not so odd as it sounds, for the organizing committee, selecting this name, was influenced by the example of the Institute of France, which is a co-ordinating body for the five French academies, both of sciences and letters, and which in an earlier stage of existence was called the National Institute of Sciences and Arts. As the Indian body was to co-ordinate scientific bodies only, it was named the National Institute of Sciences of India, leaving the field open for its foundation at a later date, for example, by the Royal Asiatic Society of Bengal (which is an academy both science and letters), of a National Institute of Letters to co-ordinate the activities of academies of letters in India, with perhaps also the formation of a National Institute of Arts co-ordinating the activities of academies of arts in India. Once this has happened, the need may arise for co-ordinating the three national institutes into a National Institute of Arts, Letters and Sciences of India as 'The Institute of India', equivalent to the Institute of France in comprehensive scope. The foundation of the National Institute of Sciences of India, although on an all-India basis, aroused a certain amount of provincial jealousy at the time of foundation, so that the present location of its office in the building of its 'grandmother', the Royal Asiatic Society of Bengal, is perhaps a disadvantage. If with the grant of a Royal Charter

adquarters is moved to Delhi, this should cause all such jealousies to be dispersed

In conclusion, it can be emphasized that Prof. Hill's report is a document of the greatest public value, which will provide a first-class stimulus to scientific progress in India. At present few copies are available in England, but it is to be hoped that this deficiency will be rectified later. It is of such importance that it should be studied closely by all who are interested in the welfare of India as conditioned by its scientific progress.

DRY FARMING PROBLEMS

Dry Farming in India

N. V. Kanitkar (Imperial Council of Agricultural Research, Scientific Monograph No. 15) Pp. x+352. Delhi: Manager of Publications, 1944. 13 12 paces, 21s 6d.

More than one fifth of India's total cultivable area crops have to be grown under conditions precarious and inadequate rainfall. The area concerned exceeds seventy-seven million acres. A partial crop failure is a serious matter for the sixty million people who live there, and for many others outside who receive their food-grains from the affected areas. The danger has become steadily greater because of the continuous and rapid increase in the total population, not only are there more to be fed, but also the increasing pressure on the land has reduced the average area cultivated by one family on the better lands, and has caused more marginal land to be taken into cultivation and has thus intensified many technical difficulties inherent in the system of subsistence farming.

During the past ten years, the Imperial Council of Agricultural Research has financed and co-ordinated the work of five special stations set up to examine the scientific and technological problems of dry farming, or crop-growing in low-rainfall areas. The scientific monograph under review is an account of the work. One of the stations, Rohtak, is situated in the north-east Punjab, on the alluvial Indo-Gangetic plain. The other four are in peninsular India and are relatively close together, but cover the two main soil formations. The Sholapur and Bijapur stations in Bombay province are on the Deccan trap, which weathers into the well-known black 'cotton' soils. The remaining two stations are at Hagari in Madras, and Rachur in Hyderabad State. They are on the red and black soils associated with ancient crystalline granite and gneiss.

The monograph contains one or two general chapters, describing the rainfall distribution over India, and the prevalent agricultural practices in dry farming in India and elsewhere, but the greater part deals with the properties of the soils and the behaviour of crops at the five stations. Extensive chemical and physical analyses of the soils were made, but except for easily predictable differences in field behaviour, associated mainly with depth of soil and the degree of heaviness, the results are shown not to have any fundamental bearing on the question whether crop yields can be stabilized or increased. This is to be expected, for the factor that overrides all others in importance is the amount and distribution of the rainfall in any season. The results of the manurial

experiments brings out that point. Farmyard and green manures were tried with conflicting results (except possibly on the eroded areas of the peninsular India stations). Thus, the heavier dressing of manure often produced a smaller yield of grain than was obtained with the lighter dressing or no manure at all. The reason was shown to be that the nutrients encourage a greater vegetative growth than the limited moisture supply could bring to maturity. The effect is well known to the cultivators, who say that manure 'dries up' the crops, and are reluctant to use dung as manure, quite apart from their need of it for fuel. The greatest importance, therefore, is attached to the problem of conserving the maximum amount of water in the soil. A great deal of laboratory and field work is discussed, varying from cultivation and run-off experiments to plant transpiration trials. The reduction of run-off water by suitably placed bunds is shown to be of prime importance, and simple methods are described suitable for the cultivators' use. The results of the tillage experiments fall into line with the knowledge now available of the physical factors concerned in the behaviour of soil moisture. Over a period of years deep ploughing is no better, and may be worse, than shallow ploughing, and repeated ploughing is found to be harmful on some soils and ineffective on others. On the other hand, repeated shallow cultivations in the monsoon period do conserve water for the use of the subsequent winter crop, partly through weed destruction and partly by the prevention of deep cracks through which water from the lower levels could escape as vapour.

Developmental studies of the important crop plants were done mainly on the millets that, as sorghum or jowar (*Andropogon sorghum*) and pearl millet or bajra (*Pennisetum typhodeum*), are predominant in these areas. Shallower seeding than the customary is recommended, because the production of the secondary and permanent root system is encouraged, a lower seeding-rate and wider spacing of the rows is also urged, because larger grain yields are obtained, and the wider spacing permits inter-cultivation up to an advanced stage of growth without injury. All this is counter to the usual practice of the cultivator, and it is no criticism of the experimental results to sound a note of caution. There may well be incidental advantages in the customary methods, to be disclosed by experiments covering a longer period of years and a wider variation of climatic conditions. For example, tillering is not desirable in dry farming conditions, and the tendency is discouraged by the close stand of plants given by a heavy seeding-rate. Indeed, an automatic selection of non-tillering types may well have been effected by the practice of close seeding, for it is pointed out in the monograph that the sorghum varieties grown in south India do not usually tiller. Plant-breeding work was outside the scope of the investigation, but promising strains evolved elsewhere were tested against local varieties, with no very significant results, except that early maturity was valuable. It must be recognized that the plant-breeding problems in food crops for dry-farming areas are of peculiar difficulty, not only because of the extreme variation in conditions from season to season, but also because the weight and quality of the stalks and leaves, which are the main fodder supply for the animals, are as important as the yield and quality of the grain.

Another point on which longer trials are needed is the relative value of rotations and the cultivators'

practice—by no means confined to India—of sowing mixed crops

The monograph concludes with an account of the combined agronomic and costings studies in which the yields and costs of the methods worked out in the experiments have been compared, on a farm scale, with the present standard practices of the cultivator. Although each item, such as bunding, inter-cultivation or manuring, gives no significant improvement, their aggregate effect over the seven years 1934–35 to 1940–41 is appreciable. The methods advocated for each of the main tracts are described in detail. The main agronomic and research problems on which further work is needed are also briefly set out. Most of them are clearly important, but the main conclusion gained from a study of the monograph is of the value that resides in the full farm trial (including costings) on a scale within the capacity of the cultivator, of the new methods against the old. It is to be hoped that this feature of the scheme will receive even more attention, for it brings the experimenter and the cultivator together on common ground.

B. A. KEEN

space to explaining why certain procedures have been adopted. It is not clear why, in the determination of manganese in steel and magnesium alloys, oxidation to permanganic acid is effected by means of ammonium persulphate and silver nitrate, while, for the same constituent in copper and aluminium alloys, potassium periodate is used as the oxidant, nor is it explained why yellow filters are necessary when using the mercury lamp for determining manganese instead of the green filters which are used with the tungsten lamp and which are specified for other determinations with the mercury lamp. With the 'direct' methods which are described, certain interferences arise, and the need to correct for these is not mentioned in the text.

The utility of the book would have been increased appreciably by an explanation of these and certain other items, some of which conflict with my own experience. However, the book contains much information which should be welcome to laboratory workers contemplating the institution of absorptiometric methods, and it should make a useful addition to the library of the metallurgical chemist.

H. C. DAVIS.

ABSORPTIOMETRIC METALLURGICAL ANALYSIS

Metallurgical Analysis by means of the Spekker Photo-electric Absorptiometer

By Dr F. W. Haywood and A. A. R. Wood
Pp. xii + 128 (London: Adam Hilger, Ltd., 1944)
18s. net

WITH the advent of the Hilger 'Spekker' absorptiometer and the pioneer work carried out by E. J. Vaughan in applying this instrument to metallurgical analysis, absorptiometric methods have become widely popular, and this book has been published in order to meet the demand that has arisen for a volume containing a collection of methods which have been devised specially for use with the instrument known as the 'Spekker'.

The first of the two sections into which the book is divided is devoted to a full description of the principles underlying absorptiometric analysis and to the construction and manipulation of the instrument. In the second part are collected twenty-six methods describing procedures for the determination of the commonly occurring constituents of commercial ferrous, aluminium, copper and magnesium-rich alloys. Composite schemes of analysis are included for each class of alloy, whereby several constituents may be determined on one initially weighed sample of alloy without the necessity for chemical separations. The operation of the methods is fully described, including details for the construction of the necessary calibration graphs.

The presence of certain anomalies tends to detract from an otherwise well-written text. Thus, the ordinates of the many specimen calibration graphs are described as "drum readings" whereas the graphs are derived from "drum differences". In no less than four instances, 'direct' methods not involving difference readings are illustrated by 'typical' calibration graphs obtained from drum differences, in spite of the fact that in two of the cases it is stated that "Difference methods are not applicable". Such lapses are apt to confuse rather than assist. It is, perhaps, unfortunate that the authors did not devote more

INTRODUCTION TO PHYSICS

College Physics

By Dr C. E. Mendenhall, Prof. A. S. Eve, Prof. D. Keys and Prof. R. M. Sutton. Pp. viii + 61.
(Boston, Mass.: D. C. Heath and Co., 1944)
4 dollars

AN introductory course in physics should aim at presenting the fundamentals rigorously without being excessively mathematical in outlook, and should also arouse enthusiasm for the subject and stimulate the student to pursue it further. In planning this text-book for first-year students in American universities the authors have clearly had these intentions in mind. Fifteen chapters are devoted to mechanics and general physics, eight to heat, thirteen to magnetism and electricity, thirteen to optics, and two to atomic physics. Modern ideas and applications are kept in view throughout the book.

The general treatment is sound, and the principles are very carefully expounded. The sections on wave motion, sound, physical optics, electron physics, and radio are good. In some places the text is necessarily condensed; for example, geometrical optics is rather briefly treated.

A few minor points suggest themselves for criticism. A simple magnifying glass is said to give "considerable chromatic aberration"; Newton's law of cooling is offered as a small-excess approximation to the fourth-power radiation law; 'thermal capacity' is used to mean thermal capacity of unit mass, as in Figs. 537 and 539 on thin-film interference and Newton's rings are inaccurately drawn.

There are more than 650 well-chosen problems with answers. The book is well illustrated and adequately indexed. Viewed in relation to the needs of British students, it should be useful for First M.C. candidates, and for biologists and others to whom more severely mathematical approach makes no appeal. Its fresh outlook and clear presentation should commend it also to those students of related sciences who wish to appreciate what physicists are trying to do and how they are setting about it.

G. R. NOAKES

American Men of Science

A Biographical Directory Edited by Jaques Cattell
seventh edition Pp. vii+2033 (Lancaster, Pa.
science Press, 1944) 14 dollars

THERE is no published record in Great Britain from which one can obtain the scientific record of a particular individual, apart from those included in "Who's Who". Attempts have been made to meet the need, but they have not persisted. North America is more fortunate. Since 1906 it has had "American Men of Science", now in its seventh edition. It is a bulky volume, in spite of the large page used, but the type is admirably clear, as should be the case in any reference book.

For those not familiar with this work, it can be described as an alphabetical list of scientific men (and women) of the United States and Canada. Under each name the following data are given: address, date and place of birth, academic distinctions with dates, posts occupied, again with dates, membership of scientific societies, with offices held, and chief scientific interests. By the ingenious use of abbreviations and italics, a surprising amount of information is provided. It is estimated that the present volume contains 34,000 names, as against 4,000 in the first edition. 250 names are marked with an asterisk as those of leaders in their particular subjects during the past five years; they are selected by popular vote.

No doubt such a compilation is expensive to produce and to keep under continuous revision, but its usefulness makes it well worth while. Is it too much to hope that the money will be forthcoming for a similar reference book of British men of science? Much of the necessary material is already in existence on the cards of the Central Register held by the Ministry of Labour and National Service.

Elementary Statistics

by Prof Hyman Levy and E. E. Preidel (Nelson's Aeroscience Manuals) Pp. vii+184 (London and Edinburgh: Thomas Nelson and Sons, Ltd., 1944) 5s net

THIS volume, in the series of Nelson's Aeroscience Manuals, covers the elementary ideas of statistical theory, including distributions, means, measures of dispersion, correlation, elements of probability, least squares and the normal distribution. The mathematical requirements are not very advanced and are carefully explained, and there are numerous examples and exercises. The book should be useful in giving a general idea of the subject to those who do not wish to specialize in it.

Statistical nomenclature is always something of a problem, but there are two expressions used in this book which the authors might reconsider. They refer to the arbitrary origin chosen to simplify the calculation of a mean as a "fictitious average", whereas most writers use the more descriptive phrase "working mean", and later on extend their usage to a fictitious standard deviation for the root-mean-square. Secondly, the authors give the result that the probability of r events in n trials with probability p is $\binom{n}{r} p^r (1-p)^{n-r}$ and call it Bernoulli's theorem. The result was certainly given by James Bernoulli (though Pascal probably knew it), but what is now generally known as his theorem in probability is the much more advanced result at the end of the *Ars Conjectandi*, to the effect that the proportion of successes in repeated trials approaches p with as great probability as is desired. M. G. KENDALL

Introduction to Differential Equations

By S. L. Green Pp. iv+140 (London: University Tutorial Press, Ltd., 1945) 7s 6d

IT is quite refreshing to see a new book on differential equations, and this introduction to the subject has been planned with skill and developed with a clear appreciation of the difficulties which usually confront the student. There are eight interesting chapters covering ordinary and first-order equations, including Bernoulli's equation, with applications to plane curves. Then follows a thoroughly sound treatment of partial equations and operational methods, with illustrations from surfaces and curves in space. Next come Lagrange's linear equation and total equations in three variables. Finally, there is a well-written chapter on solutions in series, embracing the method of Frobenius, Bessel's equation of order zero, and Laplace's equation.

The book is intended for students reading for university degrees in the faculties of arts, science and engineering. The course is one of pure rigorous mathematics with very few practical applications of the kind required by science and engineering students, although in the very numerous exercises set for the student's practice, several are drawn from physical problems. Nevertheless, the author has produced a thoroughly good book which gives a clear insight into some of the fundamental principles of so vast a subject. Not only is the volume of value to the student who is under the expert guidance of a teacher, but also the clarity of the style renders the text very readable and understandable to an intelligent private student. As the specialists in this subject are now unfortunately few, the book should be useful also to teachers for, after all, differential equations are fundamental to all applied science and engineering.

The book can be confidently recommended to all to whom the study of the subject is indispensable.

The Theory of Measure in Arithmetical Semi-Groups

By Aurel Wintner Pp. v+56 (Baltimore, Md.: The Author, Johns Hopkins University, 1944.) 2 dollars

THIS monograph, the title of which is somewhat abstruse, deals in fact with certain aspects of prime number theory. Though self-contained in presentation, it is a continuation of the author's "Eratosthenian Averages" (Baltimore, 1943). A knowledge of analytical prime-number theory and of Tauberian theorems is assumed, and even readers possessing this knowledge will probably not find the book easy reading. The greater part of it is concerned with the properties of the set of all integers that are divisible only by the primes of a given sequence, and in particular the various senses in which the set may have a 'density'.

The attitude throughout is typical of one tendency in present-day mathematics: there is a detailed analysis of the logical relation between every proposition and (almost) every other, and of the 'depth' of each proposition. Much of this is interesting and instructive, but I cannot help thinking that the book would have been more readable if the author had been less thorough.

There is a mistake (not important for the sequel) on p. 32: if $L(x)$ is a monotonic function which tends to infinity with x , and if $L(x) = O(x^\epsilon)$ for every positive ϵ , it does not follow that $L(x) \sim L(\theta x)$ for every fixed positive θ . The author has been misled by a statement of Pringsheim. H. DAVENPORT

SCIENTIFIC RESEARCH IN INDIA

TOWARDS the end of 1943, Prof A V Hill, one of the secretaries of the Royal Society, was invited by the Government of India to visit that country and discuss the organization of scientific and industrial research as part of the Indian post-war reconstruction plan, and its co-ordination with corresponding activities in Britain. Advice was also sought on current research problems, with visits to universities and other research centres. Prof Hill was thus enabled to obtain a view of the position and progress of science and industry in India more comprehensive than has been vouchsafed to anyone since the examination of the industrial resources of the country carried out by the Indian Industrial Commission under the chairmanship of Sir Thomas Holland during the War of 1914-18.

That Prof Hill took full advantage of this opportunity is apparent from his report, which has recently been published in India*. From the preface it is seen that the author regards this document rather as a logbook than as a formal or complete report. The material of the original logbook has, however, been regrouped into appropriate sections. These are necessarily many in number, so that to give a brief account of this important public document it seems desirable to mention the substance of each section, omitting Section 1, the Introduction.

Section 2 Lack of Scientific Liaison, and Section 4 An Indian Scientific Office in London

In spite of the absence of scientific and technical liaison between India and Britain hitherto, Prof Hill finds that there is a complete lack of any spirit of isolationism on the part of Indian scientific, technical, and medical men, and a frank recognition of the advantages of co-operation. To assure a liaison in the future, he proposes the establishment in London of an Indian Scientific Office with specialists in agriculture, defence, engineering, industry and medicine. This would follow a recommendation of the British Commonwealth Science Committee set up by the Royal Society.

"That a suggestion be made to the Governments of the various English-speaking countries that they should consider the possibility of maintaining permanent scientific representation in London and possibly also in other capital cities of the English-speaking world."

The Royal Society is prepared to set up a special committee of its fellows for the purpose of advising the Indian Scientific Office, the India Office, or the Office of the High Commissioner for India, on any special matter desired, for example on the filling of important scientific posts in India when suitable men are not available in India.

Section 5 Scientific Liaison with the United States.

India has many problems in common with the United States, for example, dust, erosion, floods, rural health and nursing services, control of pests, irrigation and hydro-electric developments. The British Central Scientific Office established in Washington since 1941 acts now for the Dominions as well as for the United Kingdom, and the attachment of representative Indian men of science to this office would be welcomed both by the director thereof and by the Americans.

* Scientific Research in India. By Prof A V Hill. Pp 40 (Simla Government of India Press, 1944).

Section 3 Research Training of Young Indians in the United Kingdom

India has been largely cut off intellectually for nearly five years from the rest of the world, and it is urgently necessary to resume and enlarge arrangements that existed before the War for advanced study abroad, especially in Britain, by young Indian teachers, research workers, and members of technical staffs. On the other hand, the universities, medical schools, technical colleges, and research laboratories of Britain will be overwhelmed after the War with applications from others whose claims it will be difficult to resist. This means that there will be a severe competition for such facilities, and it will be imperative that the Indians sent overseas should be carefully selected. Such training will have to be financed by Government, but as Prof Hill points out, there should be no difficulty over this as the sterling balance of India in Great Britain is already about £1,000 millions.

Section 6 A Research Background in Medical Education

As a physiologist, Prof Hill was given special opportunities of seeing hospitals, medical colleges and departments of medical science. His general criticism of medical education in India is that there is little significant research done at the medical colleges either in (a) the pre-clinical sciences (anatomy, pharmacology, physiology, or normal psychology), or (b) pathology and bacteriology, or in (c) clinical science. The fundamental cause in each case is that departments are much understaffed, and of such staff as there is, most are only part-time employees of the colleges, depending usually on private practice for the major portion of their income. Prof Hill cites the report of the Goodenough Committee in Britain as to the staff necessary for the various departments of a university medical centre, but he realizes that nothing on the same scale can be done in India at present, except at one or two centres because there are not enough people of sufficiently high standard available. Also there would probably be considerable opposition to the full-time principle. Further, the universal adoption of provision for medical education on the scale suggested is bound to be very expensive.

Section 7 An All-India Medical Centre

Recognizing the importance to any country of a really high type of medical practitioner and of a high type of medical teacher and research worker, Prof Hill advocates the establishment of an All-India Medical Centre, staffed in all departments by the ablest people available anywhere, employed full-time and adequately paid. To attain this end, liberal expenditure on scholarships will be required. Further in order to avoid communal, political, inter-provincial and inter-State rivalries and jealousies, this Centre must be established at Delhi. It is desirable, if possible, that it should be built, equipped and endowed entirely from voluntary gifts, so as to strengthen its hand against eventual political or other pressure, and Prof Hill suggests that such an All-India Medical Centre might be a very fitting national memorial to the Indian Forces after the War.

As malaria in India is the most serious public menace, Prof Hill suggests that as part of this All-India Medical Centre there should be a special hospital for the clinical study of malaria.

Section 8 Medical Research

Although medical colleges in India generally lack the research atmosphere for reasons already given, yet India has a high reputation for medical research, specially into tropical diseases (for example, malaria, cholera, plague, and kala-azar). This work has been done in the main at special institutes, for which the research department of the Indian Medical Service has been mainly responsible, helped by grants and salaries provided by the Indian Research Fund Association. The latter is an independent registered body drawing its funds from a 'user' department of the Government of India (Education, Health, and Lands). It should rank with the Medical Research Council in Great Britain, but does not because of the inadequacy of its funds. Prof Hill would like these medical research institutes, where practicable, to be brought into closer contact with medical colleges and higher medical education, to the mutual benefit of both, this should also be borne in mind when new medical research units are planned.

Since the object of medical research is treatment of the sick and improvement of public health, it may help to give some idea of the magnitude of the medical and health problems before India if the reviewer intercalates here a comparison made for another purpose of the financial provision for medical and health purposes in India and Malaya respectively. In 1938 the provision in the Federated Malay States estimates under 'Medical and Health' was 2 43 dollars Rs 4-4-0 per head or 180 dollars per square mile. In India the expenditure on medical relief in twelve provinces varied in 1936 from one anna per head in the United Provinces to 8 annas 8 pies in Baluchistan. For Madras alone, from which the Tamil population of Malaya is largely derived, the figures were 2 annas pies per head and Rs 53 per square mile. Thus for Madras the provision per person was only one twenty-sixth of that in the Federated Malay States, while measured by area it was one sixth [Straits dollar = 2s. 4d. Rupee = 1s. 6d.]

Section 9. Vital Statistics and Population

Prof Hill directs attention to the rapid increase in the population of India and to the fact that improved public health and nutrition, and diminution of the present high mortality, will cause the population to increase at a still higher rate, at least for some time; so that, contrary to what is commonly thought, industrialization, with a resultant higher standard of living, may at first also cause a rise in the birth-rate. The decision regarding the direction in which the available effort for national development should be applied depends largely upon a public understanding of the facts and probable trends of morbidity, mortality, reproduction, and population, more accurate data on these points, and their more detailed analysis, are required.

Section 10. Agricultural Research.

Agriculture is India's most important industry, but great expansion is necessary, first to provide more adequate nutrition for the present population of some 300 millions, secondly to anticipate the needs of the expected increase of population, and thirdly to provide for the expansion of crops required for industry and export.

Excellent work is being done in India in agricultural research by a variety of organizations maintained both centrally and provincially and by Indian

States. Nevertheless, the total expenditure is only two thirds of that in Great Britain before the War on agricultural research, although Great Britain has only one eighth the population and one twentieth the area. The expenditure in India is still only about one quarter of an anna per person per annum, and one tenth of an anna per acre of the total area.

Section 11. Surveys and Natural Resources

The great natural resources of India are still inadequately known. Consequently the Geological Survey must be expanded, the Botanical Survey restored, and the Zoological Survey extended. The proposed research institutes on marine and freshwater fisheries should be set up as soon as possible. Other subjects, such as water-power, water-supply, forests and soil, require fuller investigation. A central research board for surveys and natural resources is recommended.

Section 12 Industrial Research under the Government

The Board of Scientific and Industrial Research founded in 1940 has already produced important results, but the headquarters staff assisting the Director of Scientific and Industrial Research is far too small. It will be important for this Board to be in close and familiar contact with the Department of Scientific and Industrial Research in Britain and with corresponding bodies in the Dominions.

Section 13 Scientific Research by Industry

Examples are given of the giant research organizations maintained in the United States and Britain by some of the leading industrial organizations, for example, the Bell Telephone Laboratories in New York, the Eastman Kodak at Rochester, N.Y., the G.E.C. at Wembley, Imperial Chemical Industries, Ltd., Burroughs Wellcome, Lever Bros., and various engine and aircraft firms. In addition to these many private enterprises of individual firms in Britain, there are twenty-four industrial research associations maintained jointly by industry and the Department of Scientific and Industrial Research.

In India the nearest approach to the American and British model is the Metallurgical Laboratory of the Tata Iron and Steel Co. Admitting that India as a whole is poor, and that the number of men capable of the requisite effort in any field is very limited, Prof Hill thinks that Indian industry is not yet making nearly the research effort it could on its own behalf, especially as some of its industries have recently been prospering exceedingly.

Section 14 Technology.

In Great Britain there is as yet no institution comparable in magnitude, in the quality of equipment and in excellence of teaching and research work with the Massachusetts Institute of Technology at Cambridge, Mass., the view is held in Britain that two or three such institutions should be set up, or that existing institutions should be expanded for the purpose, at such centres as Glasgow, Manchester, Birmingham and London. This being the view held in a country where, after all, the conditions are not so bad, how much more can we recognize the necessity for one or two such institutes or colleges of very high standard in India? For the future of Indian industrial and agricultural development must depend on the supply of first-class technical brains, trained in an atmosphere of original research and practical

experience Of existing organizations, the Indian Institute of Science at Bangalore comes closest to what is wanted One chief purpose of the proposed new institutes of technology would be to provide teachers and research workers of high quality for other places

Section 15 Meteorological Research

The requirements of the Fighting Services and particularly of the Air Force, and the needs of civil aviation, have expanded greatly the usefulness of the India Meteorological Department, but meteorology has many other applications, for example, in radio and, in India particularly, in agriculture and in emergency warning of floods Proposals have been made to the Board of Scientific and Industrial Research for the further development of fundamental research in meteorology in India, and these proposals have been accepted.

Section 16 Scientific Instruments and Equipment

This is a key industry, and urgently needs encouragement Given training and experience, Indian workmen have all the natural aptitudes for such manufacture (as has been demonstrated for many years by the Survey of India)

Section 17 Post-War Disposal of Government Stock

A considerable amount of scientific and medical equipment and machine tools will be available after the War Prof Hill recommends that a free distribution should be made to university and other institutions of the equipment they require, for one of the most obvious criticisms of the majority of university laboratories in India refers to the poverty of their scientific equipment and the frequent absence of any proper workshop facilities and tools

Section 18 Research for Fighting Services

The existing research organization of the Defence Services in India was not designed for the contingency of India being the base for major naval, military and air operations Any improvements that can now be made in the arrangements for research in connexion with the Services should be planned not only for the present War, but also in view of the future necessity of the Government of India under a new constitution taking full responsibility for her own defence Prof Hill proposes a War Research Board in liaison with a Central Organization for Scientific Research

Section 19 A Central Organization for Scientific Research

This is the most important section of Prof Hill's report, because it contains constructive proposals for remedying the various shortcomings in the provision for scientific, medical, and industrial research that his survey has brought to his notice Prof Hill first enumerates and describes the various co-ordinating research bodies set up in Britain, namely, the Medical Research Council (1914), the Department of Scientific and Industrial Research (1916), the Agricultural Research Council (1931) and the War Cabinet Scientific Advisory Committee (1940) He proposes for India a Central Organization for Scientific Research working under the Honorable Member for Planning and Development, to control and co-ordinate six research boards, namely, medical, agricultural, industrial, engineering and war, and a board of surveys and natural resources

Section 20 A Central Register of Scientific and Industrial Personnel

The Scientific Section of the Central Register in Britain has proved of much value in selecting scientific and technical personnel for work connected with the war effort It is regarded now as an institution of permanent value to the country, but how it will be organized and used in peace-time has not been decided Prof Hill considers that a similar register would be of use to India, and has suggested that the National Institute of Sciences of India should undertake its construction The Board of Scientific and Industrial Research has made a suitable grant to the National Institute for this purpose

Section 21 Pay and Status of Scientific Workers in Government Service

One of the defects of employment in Government service both in Britain and India is that the administrator is usually much more highly paid than the scientific or technical man of the same standing, experience, training and ability, so that the scientific man has been unable to attain more than a very limited position and salary without undertaking administrative work This difference requires modification if Government is to secure the ablest men in science and give them the best opportunities for developing and using their talents

Section 22 Scientific Societies in India

Prof Hill points out that scientific societies are of two kinds, general and special, and that both kinds have an important part to play in the publication of scientific papers and results as well as in the formation of libraries and collections "Scarcely less important is their influence in making living communities out of a number of people always critical and often highly individualist In India where so many causes tend to present to separate individuals, groups and communities from one another, a strong common interest in science as a whole, or in some branch of it, could have as a by-product an important influence in keeping people working sensibly together" Prof Hill outlines some of the ways in which these societies could be assisted and encouraged by Government without diminution of their independence Once the National Institute of Sciences of India has been formally recognized as fulfilling in India functions similar to those of the Royal Society in Britain, it will be available to take up various matters with Government on behalf of sister societies, and to distribute Government grants for certain scientific purposes, such as grants for publications, and grant-in-aid for scientific investigations and for international scientific conferences A beginning has been made by entrusting the National Institute with grants for publications and for the preparation of a Central Scientific Register

Section 23 Scientific Research in Indian Universities

This subject would require long and careful study and a small commission under a scientific man as chairman might well be appointed to study the whole subject Meanwhile, Prof Hill remarks that scientific research in the universities, both for its own sake and as a background for scientific education, is the fundamental basis of all scientific progress The most notable contributions of Indian men of science have been in physics, mathematics and chemistry, and there are in fact a good many strong departments:

physics and chemistry at Indian universities. But in the biological sciences and in geology, the departments, where they exist, are nearly always small, ill-equipped and under-staffed. Even allowing for the founding of a few colleges of technology, there will be a need for universities to maintain departments in engineering of a sufficient standard to meet the ordinary needs of industry and public works. Last year the Royal Society set up a number of special committees to investigate the post-war needs of fundamental research in the United Kingdom. Similar investigations would be valuable in India.

Section 24 Private Benefactions in Science.

Although substantial benefactions have been made to science, medicine and technology in India from private sources, particularly by the Tatas, yet most scientific work in India derives its financial support from the Government. There are in India many rich men who could easily contribute substantially to scientific research. What are specially needed are scholarships, which if endowed could commemorate the names of the donors, on the parallel of the numerous endowed scholarships, studentships, and fellowships in Britain and the United States. There are already in India a few completely non-official privately endowed scientific institutions, for example, the Indian Association for the Cultivation of Science and the Bose Institute in Calcutta, and the Tata Memorial (Cancer) Hospital in Bombay. Here is a great opportunity for Indian benefactors.

BIOLOGY TEACHING IN SCHOOLS AND UNIVERSITIES

ON March 24 the Association of British Zoologists met in the rooms of the Zoological Society of London, with Prof. James Ritchie in the chair. The morning session was devoted to a discussion of the interrelationship of biology teaching in schools and universities.

In opening the discussion, Dr C. F. A. Pantin directed attention to the ultimate objects of a biological training. The first duty of a university biological department is to advance knowledge. The depletion during the War of university staffs in zoology has shown how serious the situation could become when research ceases and when individuals with expert knowledge in special fields cease to be available. The training of able students for university posts is essential. Nevertheless, the numbers required each year are few, and the vast majority who receive biological training at a university aim at some other professional career such as teaching in schools.

Important as biology is in education, one would not wish to produce biological instructors simply for the sake of training yet more. In the past, preliminary training for medicine occupied the largest number of zoological students who aimed at other careers, though their contact with the subject was brief. Only a few zoologists were absorbed into other professions. But one hopes to see in the future a steady and increasing demand for careers in veterinary work, agricultural entomology, fisheries in Britain and in the Colonies, as well as in special activities such as the protection of stored products and the prevention of fouling of ships.

It is probable that more zoologists will be required for professional or Government services than for industry. The problems of applied biology are rarely narrow and local. They may cover the whole country and may lead into physics, chemistry, mathematics and even more distant studies like sociology. There is little scope for technicians with limited but intensive training comparable to that of the radio expert in physics. The social importance of biological problems is not less for that reason.

However, the War has shown the value in an unexpected direction of the wide training a biologist receives. It has been the common experience that biologists are peculiarly fitted for the varied problems which come under the heading 'operational research'. Their advantage seems to depend on the fact that they are more accustomed than the physicist to hunting for general principles in a mass of apparently unconnected particular instances. The biologist cannot afford to reject any problem just because he is unable to examine and control it at leisure in the laboratory. He must often start with varied, qualitative and above all fugitive data. His problems are often of a kind which a physicist would reject as unsatisfactory for attack. But it is the solution of just this kind of difficulty which is needed in everyday life. We may hope that after the War biological students may find their place, attacking the general problems of industry just as they have attacked those of operational research.

It is clear that the preparation of the young biologist for any career will require a wide and sound scientific training. How far does the present educational system provide this? The universities have often complained that the teaching at school is too specialized; an attempt is made to cover too much ground, so that elementary knowledge is weak and the necessary revision at the university bores the student. It is also claimed that another result of this specialization is lack of general education and inability of the student not merely to read languages other than his own but even to express himself in his mother tongue. Though this may be partly true, it is open to question whether the degree of illiteracy among biological students is as great as some have supposed. Another criticism directed at university entrants in biology is that their knowledge of mathematics and physical science is too weak. Many university teachers have been told "I took up biology because I was not good at physics".

In all these criticisms there is some substance. But from the point of view of the universities, perhaps the most serious criticism of all is that under the present system the standard of knowledge of entrants in biological subjects varies so greatly that the construction of satisfactory preliminary courses at the university becomes extremely difficult. Pessimists have said that the only solution is to begin biological training at the university. They quote the case of the classic who turned over to biology and outstripped the rest of the class. They usually omit to remark that this is only characteristic of men of outstanding ability who would succeed in whatever direction they turned. But, in fact, teaching of biology at schools has come to stay. It must never be forgotten that the majority of school-children are not in fact going on to a university at all, and the case for giving the general citizen an elementary biological training is overwhelming. Moreover, a good school training in biology can be of the very greatest value to the university entrant. Time

presses, and education is long and expensive. It may be further encroached upon by national service. Everything that helps the student on his way without detriment to educational principle is to the good.

Those who are responsible for teaching in schools fully agree that the relation between natural science at school and at the university is very far from satisfactory. They point out, however, with justification that they are the victims of circumstances. They complain of the very high standard demanded in scholarship examinations, particularly those of the colleges at Oxford and Cambridge. It was realization of the force of this complaint which led to recent conferences between school teachers and college and university officers at Cambridge. As a result of these conferences, the principle was accepted that the factual basis of the scholarship examinations should be the same as that for the higher school certificate examinations in natural sciences subjects. But while this should ease the situation, nothing can really justify the use of an examination designed to select the very few ablest university candidates as the basis of natural science education for every kind of child at school.

University scholarships are not alone responsible for the school masters' difficulties. The discussion showed how the laudable effort to reduce the long and expensive period of professional training, particularly for medicine, has resulted in specialized work being pushed into preliminary examinations. In England, preliminary medical examinations are commonly taken at school, and this has led to great specialization—a difficulty avoided in Scotland, where the examination remains a university one. Yet another difficulty faces the schools in that there are no fewer than eight separate bodies controlling certificate examinations, each with its own syllabus and each giving the successful candidate special 'credits' which are of university rather than school importance. It thus comes about that a biology master at school may have to break up quite a small class into three or four groups each pursuing a different syllabus. Further, these syllabuses are not constructed primarily because of their educational value at the school-level but are determined by university and professional requirements.

What can be done about this? The discussion showed the unanimity of opinion in favour of biological training at school being based upon the educational needs of the school-child. The needs of the majority of students who will not in fact go to a university are paramount, and these students require a general biological education. This would in fact also be desirable for the few who are going on to a university. In either case, specialized study anticipating later professional requirements is undesirable. Thus, many schools have complained of the demands made by embryology in the preliminary medical examinations. A thorough grounding in embryology is justifiable for the student of medicine at some stage, but detailed embryology is beyond the average school-child, and attempts to cover it make far too large demands upon teaching time.

It was pointed out in discussion that though special educational requirements should be discarded in favour of general biological syllabuses for schools, there is great advantage in some part of the syllabus being studied intensively. As remarked in the syllabuses recently published by the Cambridge Joint Advisory Committee for Biology, one cannot train

scientific judgment when knowledge in all parts of the subject is scanty. But the part selected for intensive study should be one suited to the boy or girl at school, as is, for example, natural history. Further to ease the burden on the school-master and also to help preliminary work at universities, it is desirable that the school biological syllabuses of different examining bodies should have common aims and cover approximately the same kind of ground. Finally, in the interests of wider education, the total time spent at school on biology and indeed on natural science should not encroach too far on other fields of education. More than one recent conference between school-masters and university teachers have recommended that natural sciences subjects should not occupy more than two thirds of the teaching time.

It was with these things in mind that the Cambridge Local Examinations Syndicate and the Cambridge Syndicate of the Oxford and Cambridge Schools Examination Board recently set up a Joint Advisory Committee with members of the school-teaching profession to examine and report on their higher certificate syllabuses in natural sciences. These reports have now been published, and have in general had a very favourable reception. This Committee has tried to base its syllabuses on the various natural interests of the child. In zoology it has taken these to be the structure and function of the human body, the variety of form and function in the animal kingdom, natural history, the relation of animals to man and other topics. Embryology is much reduced compared with current syllabuses. On the other hand, great stress is laid on the importance of natural history, because of the training it gives in observation and in the acquisition of knowledge at first hand, as opposed to the passive absorption of selected ideas in class. The syllabus indicates how the science of zoology can be built up from this basis. Thus the study of man is a starting point, rather than an anthropocentric goal. Scientifically this is good, because many questions of structure and function first arise in the study of one's own body and can most easily be examined in it.

One other question of considerable importance was discussed. Is it better that a young biologist at school should study zoology and botany as separate subjects or make one common study of biology? Certainly at an elementary stage there are no good grounds for any separation. From an educational point of view the single subject of biology has every advantage. But the encouragement of biology rather than zoology and botany separately, raises certain difficulties in examinations. The school biologist is better trained who takes, say, biology, chemistry and physics rather than zoology, botany and some other subject. Yet the biologically minded student who takes the first combination stands at a disadvantage, since he has only one subject and not two in which he is likely to score credit. His situation is even more unsatisfactory when compared with that of the boy or girl taking physical sciences, who can choose three subjects, mathematics, physics and chemistry, for all of which he is mentally apt. This difficulty must in some way be overcome. It is part of a general problem which faces the educational system of Britain at the present time. How can we encourage a student to take subjects in which he does not excel, but which will be of the utmost value to him educationally, or even for the prosecution of his favourite study at a more advanced stage?

OBITUARIES

Mr A. R. Hinks, C.B.E., F.R.S

THE death, on April 14, at the age of seventy-two, of Mr Arthur Hinks, for thirty years the distinguished secretary of the Royal Geographical Society, leaves a gap which it will be difficult to fill.

A mathematician and a graduate of Trinity College, Cambridge, Hinks devoted his attention to astronomy during the earlier part of his career, and it was for his work bearing upon the determination of stellar and solar parallax that he was awarded the gold medal of the Royal Astronomical Society in 1912, and was elected a fellow of the Royal Society in the following year. In accordance with a tradition observed by Sir Isaac Newton, but reaching back to the Greeks, geography is merely a branch of astronomy, and Mr Hinks's interest in the earth as a planet, expressing itself in a series of lectures, and later of admirable text-books, upon surveying, cartography and map projections, led to his connexion with the Royal Geographical Society. His appointment as assistant secretary, and two years later (in 1915) as secretary, in succession to Sir John Keltie, was particularly apposite, since the fellows and Council of that Society were still primarily interested in travel and exploration, and Mr Hinks not only organized and supervised the *ad hoc* instruction of intending travellers in practical surveying, but also was able to assist them in the interpretation, working up and presentation of their observations on their return. The most recent edition of the well-known "Hints to Travellers" is largely from his pen, and represents the fruits of his numberless contacts with British and foreign explorers. During the War of 1914-18, he was also able to be of very great assistance to the military in solving or advising upon various technical problems connected with maps, and it was for his services in this direction that he was made a C.B.E.

Mr Hinks's own preoccupation with mathematical geography, and the Society's traditional function as a headquarters for exploration, had the result that the university geographer, attempting the systematic regional study of the earth and the interpretation of landscape, received rather a cold welcome at the House in Kensington Gore. The secretary was also editor of the Society's *Journal*, and his criticism and rejection, as editor, of academic research was by many felt to be unsympathetic and unduly harsh; but actually his standard of scholarship was high, while the achievements of British geography have been decidedly mediocre. The reason is not far to seek. There is an almost complete absence of scholarships, fellowships, research endowments and other opportunities for advancement and reward in geography, which naturally deters young men and women of first-class calibre from reading the subject at the universities. It was peculiarly unfortunate, in view of the help he might have given, that Mr Hinks accepted the Royal Society's view that geography is not a part of natural knowledge, and does not fall under the head of "the examination and investigation of experiments and of natural things" for which under the Charter of 1663 that Society could lawfully hold meetings. Hence, except in its mathematical aspects, the subject of geography lacks status and can command no financial assistance.

Within his chosen field, Mr Hinks himself contributed many valuable papers to the *Geographical*

Journal, the subjects including photogrammetric survey, boundary delimitation, geodetic problems, cartographic technique, and novel or neglected projections. Quite recently, he designed and calculated a series of maps on the oblique Mercator network, accompanying them by a family of curves by means of which great circles could be plotted between any two points. The maps were immediately used in a discussion of the future of civil aviation. He was responsible, too, for the design and calculation of the very beautiful and effective map of Europe and the Middle East which was drawn by the Society's draughtsmen and published for the British Council. For beauty and elegance in map production, in so far as it was an expression of perfect fitness for function, he was always deeply concerned, and took part in many lively discussions upon alphabets and lettering with the officers of the Ordnance Survey.

Mr Hinks's eminence in the fields of geodesy and cartography received world-wide recognition, and he was the recipient of the Royal Geographical Society's Victoria Medal in 1938, followed by the American Geographical Society's Cullum Medal in 1942. The present War robbed him of those years of leisure in retirement which were his due. He remained at his post, and only a few days before his death was answering correspondence upon projections, revising his standard text-book on the same subject, and giving vigorous expression to his opinion of a poorly conceived, badly designed and wretchedly executed map issued by a great public corporation.

E. G. R. TAYLOR

Mr. G. V. Boys

GEOFFREY VERNON BOYS, secretary of the Institution of Naval Architects, died on March 15 at St Mary Bourne, Andover. He was the only son of the late Sir Charles Vernon Boys, whose death at the age of eighty-nine occurred a year ago, and was born in 1893 at Oxford, where his father was then repeating, with improved accuracy, the Cavendish experiment, when he obtained 5.57 for the mean density of the earth.

G. V. Boys was educated at Marlborough and proceeded to Trinity College, Cambridge, in 1913. At the outbreak of the War in 1914 he served in the Royal Engineers, but was taken prisoner in August 1914. After spending some time in German prison camps, he was interned in Switzerland and resumed his residence at Cambridge in 1919, graduating in 1921. In the year following he lectured at the Royal College of Science, South Kensington, and in January 1922 joined the staff of Messrs. Kennedy and Donkin. As a senior engineer in this firm, he showed great skill in the use and application of mathematics and physics to engineering, and was frequently given difficult problems in design and always solved them. His work had the great merit of being accurate, and he possessed the admirable quality, especially in the application of science to engineering, of judging correctly the accuracy required without wasting time on irrelevant places of decimals. He was engaged *inter alia* on the Uhl River hydro-electric scheme for the Punjab Public Works Department and on many electricity transmission schemes, such as those in the Isle of Man and in Northern Ireland. He was responsible for the design and testing of the Central Electricity Board's grid towers in Scotland and north-west and south-

west England, which are used to transmit electricity at 132 kilovolts throughout that part of the country. The work which he carried out for Kennedy and Donkin was of great value to them and was much appreciated on account of his sound judgment and his facility in finding the best method of attacking any complex problem.

In 1935 Boys was appointed secretary of the Institution of Naval Architects. He filled this post with great success and was popular with the members and staff and trusted by successive presidents of the Institution—the late Viscount Stonehaven and Admiral of the Fleet Lord Chatfield. Boys was also a good linguist, and when the Institution was invited to Germany in 1939, he attended as one of its representatives. He quickly became convinced of Germany's warlike intentions and on his return volunteered his services to the Admiralty. His offer was accepted, and in September 1939 he moved to Bath and became professional secretary to the Director of Naval Construction, retaining general control over Institution affairs. Although he was not a naval architect by training, he was soon giving useful help to the directors under whom he served—Sir Stanley Goodall and Mr C S Lillierap. Ill-health forced him to retire from the Admiralty in 1944. During his fatal illness he wrote or dictated letters to the office and his friends so long as he was able and showed great courage and patience throughout.

Boys had a good personality, mixing well with those he met, and was a man of knowledge and ability in many directions. He leaves a widow and a young son.

L WOOLLARD

Mr. F. Percy Smith

F. PERCY SMITH, one of the pioneers of British film production, died on March 24.

It was in 1908 that Smith threw up an appointment with the Board of Education and gave himself up entirely to cinematography. He started working for Charles Urban and specialized in Nature and microscopic work. Even in these early days he had developed his special technique of speeded-up cinematography and had shown, in "The World before your Eyes" series, the beauties of the flower unfolding on the screen. Smith worked for Charles Urban for several years, but had no real opportunity of showing what he could do until in 1921 he joined Bruce Woole and took his part in the production of the "Secrets of Nature" series which, largely through Smith's contribution, has gone on ever since and has thus created a record for this or any other country of continuous production over a period of twenty-five years.

British cinematography has suffered a great loss as Smith's work was known and admired in nearly every country where cinematograph films are shown. Whenever a representative selection of British films has been shown to special audiences, something emanating from Smith's studio has always been included. In 1930 at the gala presentation organized by the Federation of British Industries to the delegates to the Imperial Conference his "Plants of the Underworld" was shown, and later, in 1933 at a similar gala presentation to world press representatives, he contributed "Gathering Moss".

Although much of Smith's work was shown in the theatres, and many will remember the weird beauty of his "Plants of the Underworld" and the drama of "The Life of a Plant", yet his main work was

rather in the scientific film. Here he was undoubtedly in a class by himself, especially in the field of biology. In collaboration with Dr Julian Huxley, he contributed a series of biological subjects that have done more to bring about the use of the cinema film in schools than any other single event. In connexion with this, Dr Julian Huxley remarks "Percy Smith had extraordinary patience and pertinacity in getting the results he wanted. In addition he was extremely ingenious in devising apparatus and gadgets of every description. His work was essential for the building up of high technical standards in the difficult art of biological film-making."

Although his studies of the chick and the frog were of very high quality, there is little doubt that it was his botanical films made in collaboration with Dr E J Salisbury that opened up fresh possibilities to the cinematograph camera. As Dr Salisbury writes "Mr Percy Smith was a first-rate cinematographer, who combined great technical skill with patience and observational acumen. The film which he took of the growth of roots is not only one of his most successful efforts, but exemplifies these qualities in a high degree. The knowledge of what is the life-history of a plant or its normal behaviour under particular conditions is not the end, but only the starting point in their pictorial portrayal. It was in the patience necessary to ascertain the precise phase of a phenomenon that best lent itself to pictorial record that Percy Smith exhibited so high a degree of skill almost amounting to genius."

The study, research and the patience that were necessary to complete such subjects as the life-histories of the fern and the moss were enormous, and nobody except a person whose sole interest lay in his work would have undertaken them. The fern film took three years to complete and that on the moss two and a half.

In the field of international competition, Smith's work had upheld the prestige of Great Britain, and prizes had been awarded his films in open competition against all comers, notably at Brussels and Venice.

Smith's was a strange personality. He had no thought for anything other than his work, and the only assistant he would tolerate was his wife. He was of a retiring and shy disposition, but with a keen sense of humour and a positive genius for the invention of 'gadgets'. In his studio he had machines to record the growth of plants, these, of course, had to work night and day. They were controlled by clockwork, made by himself, and it was essential they continued to function continuously, sometimes, for several weeks. As even he must sleep sometimes, he devised a means whereby if any of the machines stopped for any reason, it rang a bell by his bedside and woke him up.

In Percy Smith the British film industry loses a lovable personality and one whose work has done more than a little to uphold the prestige of British films. The sympathy of all will go out to his wife, who assisted him so ably, in her great loss.

WE regret to announce the following deaths

Miss Emilia F Miram, of the Zoological Museum of the Academy of Sciences of the U S S R

Prof Andreas P Semenov-Tian-Shansky, honorary president of the Russian Entomological Society

Prof William Trelease, emeritus professor of botany in the University of Illinois, on January 1, aged eighty-seven

NEWS and VIEWS

Chemical Society: Retirement of Mr. S. E. Carr

FIRST as assistant and, later, general secretary, Mr Stanley Ernest Carr has been identified with the Chemical Society for forty-two years. Mr Carr's life's work has been such that much of the Society's progress must be ascribed to his guiding influence during that long period. Of necessity, there have been frequent changes of honorary officers of a learned society, and it has to be left to the more permanent general secretary to preserve the continuity without which schemes for the advancement of the society and the science it represents would frequently fail or, at best, be only partly successful. The Chemical Society has been particularly fortunate in having Mr Carr as general secretary for so long and during two periods of difficulty arising from emergencies when the importance of chemistry to the nation has had to be recognized. The history of the Chemical Society since the beginning of the present century is, indeed, almost an account of Mr Carr's successful work for the Society and British chemistry. For example, on behalf of the Chemical Society, he has been intimately concerned with the introduction of the publication of the "Annual Reports on the Progress of Chemistry" (1904), the setting up of the Bureau of Chemical Abstracts (now, the Bureau of Chemical and Physiological Abstracts) and the setting up of the Chemical Council, so achieving co-operation with other societies and organizations concerned with chemical interests in Britain. Fellows of the Chemical Society owe a great debt to Mr Carr both for his efficient work for the Society and for his courtesy and kindness at all times. They will wish him a successful retirement in which he will have happiness in the knowledge of the gratitude of those with whom he has worked.

Royal Geographical Society Awards

THE King has approved the award of the Patron's Medal of the Royal Geographical Society to Sir Alfred J Mackinder, for his eminent contributions to geography, including the first ascent of Mount Kenya in 1899, and his long and distinguished service to the advancement of the science. His Majesty has given permission to the Council to postpone a recommendation for the Founder's Medal for 1945. The Council has resolved that the grant of the Society's awards for 1945 be postponed.

Lingualism in Indian Education

In the *Journal of Education and Psychology* (London, 1, No 2, July 1943), A I Patel discusses lingualism and Indian education. He surveys the results of the use of English as the medium of instruction in the earlier stages of education before the mother tongue has become an adequate mode of expression. He concludes that bilingualism hinders the process of education, renders its victims emotionally unstable, prevents moral development, dries up the sources of creative ability, and makes misfits of the students, adjusted to neither cultural group. The remedy is to realize that at present Indian education is neither Indian nor education. English should not be taught in the primary stage, but postponed to a late period in the secondary stage. It could rank as a second language, leaving the vernacular to be the medium of education. The present system, centred round the teaching of

English, has had a fair trial and has failed. The writer admits that there will be difficulties but that for the sake of India they ought to be faced and overcome. He recommends the use of Basic English, when the time comes to learn English. He does not want to exclude English because it is the one language which can provide vital contact with European culture and civilization, but Indian language and literature should be the basis of education.

Science-Teaching in Schools

YET another body speaks on the teaching of science in the schools of the future. The Essex Science Teachers' Association is an active one, holding several meetings each year under the able guidance of its secretary at the Mid-Essex Technical College, Chelmsford. It works for the advancement of science-teaching in all types of schools. The interim report, a fourteen-page brochure containing aims of science-teaching, suggestions for content of science syllabus and facilities for the teaching of science, is intended to be followed up with a series of publications dealing with science for the eleven-to-thirteen age-group, laboratory accommodation, etc. (The Content of the Science Curriculum in Post-Primary Schools. Interim Report of a Sub-Committee of the Essex Science Teachers' Association. Pp 11+14. Chelmsford Mid-Essex Technical College, 1944. 6d.)

The aims are admirably stated, a concise expression being given as "aims . . . to encourage pupils to learn the facts, principles and skills of science, to appreciate the spirit and service of science, and to acquire rational methods of working, observation, thought and expression." Material for the content of the syllabus, its order and depth of treatment, local environment, time requirements, scope and practical applications are all discussed. Rational suggestions are made with regard to sizes of classes, rooms and laboratories, equipment, workshop and repair facilities, staffing. Particularly valuable is the contribution of the non-science headmaster that concludes this much too brief report, many of the contents of which needed stating long and loudly, it is to be hoped that further publications will amplify many of the sections on facilities and content of syllabus.

Sixth Form Mathematics

THE Cambridge Joint Advisory Committee for Mathematics, set up in November 1943, consists of eight school teachers and eight representatives of the University of Cambridge. The Committee has published a pamphlet "Syllabuses for Examinations taken by Sixth Form Pupils" (Cambridge University Press, 1945. 6d.), containing a scheme of two years' work for higher school certificates and also for college entrance scholarships. It is recommended that the entrance scholarship papers should follow closely those for higher school certificates, and not give too much weight to advanced work. Pure and applied mathematics are regarded as a single subject, to which, even for specialists, not more than half the total teaching periods should be devoted. Another main subject, for example, physics, should also be taken, and at least one third of the total time should be reserved for general subjects. Having regard to the different requirements and levels of ability of the pupils, the Committee provides four different syllabuses, 'Subsidiary', 'Ordinary', 'Further', and 'Higher'. The 'Subsidiary' would be sufficient for

those taking mathematics as an auxiliary to economics or biology, and includes, as an option, statistical method. This is an innovation of the greatest importance. The 'Ordinary' is roughly the present higher school certificate course for a 'Principal' subject, but again statistics may be taken if desired. The 'Further' and 'Higher' are suitable for candidates for university scholarships. Astronomy may be taken instead of some of the more advanced mechanics in the 'Further' course.

The Committee recognizes the great diversity of the needs to be catered for, and has tried to make the syllabuses as flexible as possible. Criticism and comment will be welcomed, and a revised edition of the syllabuses will, if necessary, be issued in the light of experience and of suggestions received. It is hoped that the Oxford and Cambridge Joint Board, the Cambridge Local Examinations Syndicate, and the Cambridge colleges will accept the syllabuses as a basis for their examinations. Approval has already been expressed by the Institute of Actuaries, and it is hoped that other professional bodies and the Services will also find them suitable.

National Museum of Wales

AN important aspect of the annual report for 1943-44 of the National Museum of Wales is the evidence it provides of a council fully conscious of the Museum's educational function, which even under war-time conditions has been considerably developed. Lectures, demonstrations, special exhibitions, loans to research workers and schools, and the provision of facilities, material and instruction for teachers and students engaged in specialized work are striking examples of the valuable work being carried out by all departments. For the future, the opportunities provided by Section 100 of the 1944 Education Act for closer co-operation between schools and museums have been recognized. Accordingly the Council, in collaboration with the Welsh Department of the Ministry of Education, has already given consideration to the matter in relation to Welsh schools. Other authorities responsible for the conduct of museum affairs in a post-war world would do well to note this action. The Council also reports that its Memorandum on Museum and Art Gallery Services in Wales and Monmouthshire (summarized in the 1942-43 Report) has been forwarded to the Minister without Portfolio by the Welsh Reconstruction Advisory Council. With it the latter has sent a communication asking the Minister to give special attention to the importance of extensions to the National Museum being recognized as part of the official schedule of post-war reconstruction work; the provision of Government funds for an open-air museum as an essential auxiliary to the National Museum, and the establishment of a museum grant committee, there being a particular need for a grant for technical assistance to local museums in Wales.

Among the many other activities reported by the Council the following are noteworthy. Department of Botany: continuation of research on atmospheric pollen (see *New Phyt.*, 43, 49, 1944, and *Museums J.*, 44, 146, Dec. 1944). Department of Zoology: completion of a detailed list of all the mammalian remains of historic interest, and the continuation of the bibliographical indexing of Welsh species. Department of Archaeology: continuation of survey work on ancient buildings in Monmouthshire, and the preparation of a report on the antiquities of West Gower (at the request of the Ancient Monu-

ments Department of the Office of Works). Department of Geology: the provision (in response to many inquiries on various aspects of geology) of information relative to raw materials, water supply, drainage and roads. The Museum has made many interesting and valuable acquisitions during the year, and it should be noted that the important collection of Celtic antiquities found in 1943 in a bog near Holyhead, Anglesey, is now in the custody of the Archaeological Department. A full bibliography of the publications of the National Museum of Wales is a useful appendix to this report.

Museums and Post-War Educational Development

THE annual report of the Manchester Museum (University of Manchester), while stating that the usual museum activities have been carried on during the year 1943-44, points out that its functions in relation to future educational developments can only be properly fulfilled when provision is made for a increase of technical staff, and for adequate working accommodation. As the report states, these needs are common to museums throughout Great Britain. At the present time, however, there are few or no signs that such needs—together with many others—will be met in the near future. No doubt the solution of the problem might be hastened if the Ministry of Education were to recognize in a more practical manner the considerable educational potentialities of these institutions. In the meantime, for lack of growing space, a valuable public service is unable to progress beyond its 'germination' stage.

Temperature Control

THE lecture on 'The Practical Side of Fine Temperature Control' delivered by L. T. Townson at R. Barrington Brock to the Society of Chemical Industry in May of last year is now available in pamphlet form as No. 11 of the review *Service Science* issued gratis by Messrs. Townson and Mercer Ltd., of 390, Sydenham Road, Croydon. The lecture dealt with constant-temperature baths, particularly for medium temperatures, and concentrated attention mainly on water baths, which the authors point out are superior to air baths both because of the low heat capacity of air and also, they say, because low density gives it little inertia, and enables vortices with consequent temperature differences, to form more easily. The first matter which the authors stress, and on which they give experimental evidence, is the importance of stirring. They believe that paddle stirrers are not sufficiently effective, and that the whole of the liquid must be caused to flow through the bath, this involves the use of a second chamber of some sort, either entirely separate, or formed within the bath by means of false sides or some similar device. Other points which are discussed in the lecture are the effect of thermostat lag, the advantages and disadvantages of proportional control, and the effect of heat losses. It is apparently realized that these lead to permanent differences of temperature in the bath. In this connection lagging is discussed, and the advantages of reflecting metal sheets as insulation are pointed out.

Biological Unit for Vitamin A

VITAMIN A is unique in that the unit by which it has been defined has been measured with reference to a precursor, β -carotene, and not to vitamin itself. This biological unit based on β -carotene standard is cumbersome and subject to gross errors.

Certain foodstuffs are now required by law to include vitamin A, and regulations require that foodstuffs, claiming to contain vitamins, be labelled in units. Manufacturers who to-day handle vitamin A are dependent on the spectroscopic method of assay using the extinction coefficient at 325–328 m μ as a linear function of vitamin A activity, and it has been necessary to adopt a factor to relate the spectroscopic reading with the biological international unit. Such factors have become standardized in Great Britain and in America although at different levels.

N T Gridgeman, in "The Estimation of Vitamin A" (Lever Brothers and Unilever, Ltd., 74, 1944), assembles and reviews the evidence. He shows that these factors do not rest on a sound scientific basis, due mainly to the occurrence of a number of vitamin A congeners and to the fact that the biological test is very complex, for example, there is the synergism of vitamins A and E. He recommends the adoption of a new unit based on the spectroscopic assay method. A provisional skeleton definition would be the unit of vitamin A is that quantity which made up to 100 ml with a specified organic solvent gives a solution having an extinction coefficient at 325 m μ of 0.005. He adds that "the quest for a new easily measurable physiological criterion of response, sharply related to increasing dosage, prophylactic or therapeutic, of vitamin A, can be regarded as a fruitful research problem".

Stars of the Southern Skies

LEAFLET No 188 (Oct. 1944) of the Astronomical Society of the Pacific, by Leon E Salanave, gives a simplified star chart and guide to observations with the unaided eye and with field-glasses. It has been compiled in response to numerous requests, from the South Pacific in particular, for star finders, constellation guides, etc., and is specially designed for a latitude 10° south of the equator. Only those stars are shown which are necessary to suggest the constellation figures, and after learning these the observer's knowledge can be extended with the aid of more complete charts. There is a brief description of the constellations, stars of the first magnitude, and of a few interesting objects such as the Great Nebula in Orion, the Large Magellanic Cloud, etc. The Leaflet will serve a useful purpose for those engaged in military operations who have found themselves under unfamiliar skies.

Association of British Zoologists

THE Association of British Zoologists, which had not met since January 1939 owing to the War, held its tenth annual general meeting on March 24 in the rooms of the Zoological Society of London. Proceedings opened with a business meeting during the course of which the following elections were made or, having been made by the Council, were confirmed: *President*, Prof James Ritchie, *Hon Secretary*, Dr John Smart, British Museum (Natural History), London, SW 7, *New Members of Council*, Prof.

L Mackinnon, Prof James Gray, Mr J C F. Fryer, Prof C. H. O'Donoghue and Wing-Commander F S Russell, *New Trustees*, Mr J. T. Saunders and Dr W E Swinton. After the business meeting, the Association proceeded to a discussion of the "Post-War Teaching of Zoology in Schools and Universities". This discussion was opened by C F. A. Pantin and is reported elsewhere in this issue (see p 535). In the afternoon, a series of four shorter discussions centring around the general topic of "Some Developments of Post-War Research"

was engaged in. The first, on "Marine Investigations", was opened by Dr E S Russell and this was followed by one on "The Work of the Zoological Society" opened by Dr S A Neave. Mr J C F. Fryer opened the next, on "Zoological Interests of the Agricultural Research Council", and the final topic was "Freshwater Investigations", opened by Dr E B. Worthington.

Frank B. Jewett Research Fellowships

FIVE Frank B Jewett Fellowships for research in the physical sciences have been awarded by the American Telephone and Telegraph Co to Dr Elliot R Alexander, Dr Albert S Eisenstein, Dr Kenneth Greisen, Dr Boris Leaf and Dr Harry Pollard. The availability of these men to accept their fellowships will depend upon the progress of the War, as each is now engaged in essential war research. Dr Alexander is at present a research chemist at the du Pont Experimental Station at Wilmington, Dr Eisenstein is a member of the Radiation Laboratory staff at Cambridge, Mass., Dr Greisen is engaged in war work at Santa Fé, New Mexico, Dr Leaf is an associate chemist in the Metallurgical Laboratory of the University of Chicago, and Dr Pollard is a member of the Applied Mathematics Group at Columbia University.

Announcements

THE following appointments have recently been made in the Colonial Services: D Sturdy, senior agricultural officer, Tanganyika, to be director of agriculture, Jamaica; E T. Ward, agricultural superintendent, Windward Islands, to be agricultural officer, Tanganyika; R K Hardy, assistant government chemist, Nigeria, to be government chemist, Nigeria; D R Rosevear, senior assistant conservator of forests, Nigeria, to be conservator of forests, Nigeria.

THE following appointments have been made to the technical staff of Ashe Laboratories, Ltd, 120/2, Victoria Street, London, SW 1. Mr D I Duveen now takes charge of the development of full-scale production of amino-acids and protein digests; he has worked in Paris and in London and has published papers, some in collaboration with Dr J Kenyon, on problems connected with optical activity and the preparation and isolation of substituted naphthalenes and their photo-oxides. Mr Duveen will be assisted by Mr E G Hatten, formerly of Glaxo Laboratories, who has had experience in the production of fine chemicals and therapeutic preparations. Mr H S Young, formerly with Messrs Crosse and Blackwell and C and E Morton, Ltd, has been appointed food chemist and will be responsible for the control and development of food preparations manufactured by the Ashe Laboratories. Mr P Lewis Smith, formerly with Messrs Eli Lilly and Co, has been appointed to the pharmaceutical section, where his long experience in the Far East will be of great assistance in the company's export programme. The new appointments will be under the general direction of Dr W E Gaunt, who is known for his work on amino-acids and protein digests.

ERRATUM—The new insecticide described in the communication entitled "Acaricidal Property of a New Insecticide, Hexachlorobenzene" printed in *Nature* of March 31, p 393, was wrongly named. The substance referred to is benzene-hexachloride, or 1.2.3.4.5.6 hexachlorocyclohexane.

LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications.

A New Rhesus Antibody

AN antibody of a type hitherto undescribed, which discriminates between certain Rhesus genotypes, has been found in the serum of a male patient, H.Br., of blood group O, suffering from a hæmolytic anaemia of uncertain aetiology. He was transfused on numerous occasions with unselected group O blood and ultimately began to have reactions suggestive of incompatibility. His serum was found to contain an agglutinin which clumped the red cells of all, but about 4 per cent of group O donors. The cells of one group O Rhesus-negative subject, C.K., were agglutinated down to a dilution of 1 in 640 by serum obtained in April 1944. In May 1944 the titre against cells of the same subject had fallen to 80 and in January 1945 to 20. Most of the investigation was carried out with the May serum.

The red cells of 662 group O donors and other subjects, unselected with respect to the Rhesus factor, have been tested with the serum. Twenty-seven, or 4.1 per cent, are unagglutinated or 'Br-negative'. Sixty-nine group O *Rh*-negatives, partly included in the above 662 subjects, have all been found to be Br-positive, and in addition 5 Br-negatives selected from a different panel from the 69 *Rh*-negatives have been found to be *Rh*-positive.

The Rhesus genotypes of eight Br-negatives, including H.Br. himself, were determined by Dr R. Race and the late Dr. G. L. Taylor. Seven, including H.Br., fell into the class including *Rh*₂*Rh*₂ and *Rh*₂*rh*, and one was *Rh*⁺*rh* or *Rh*⁺*Rh*⁺. The father and only child of H.Br. were found to be respectively *Rh*₂*Rh*₂ or *Rh*₂*rh*, and *Rh*₁*Rh*₂, both Br-positive.

Some Br-positives are extremely weak reactors with the rather low-titre specimens of serum now in use, and it appears probable that a few of the apparent negatives would react positively with a stronger serum. Nearly all the weak reactors tested for their *Rh* genotype have contained the gene *Rh*₂ or *Rh*⁺. *Rh*-negatives are almost invariably among the strongest reactors.

These properties are consistent with those of the antibody η predicted by Fisher¹. η should agglutinate the cells of all *Rh* genotypes containing the genes *Rh*₁, *Rh*⁺, *Rh*₂ and *rh*, but not those of genotypes composed exclusively of *Rh*₂, *Rh*⁺, *Rh*₂ and Fisher's hypothetical *Rh*₃. Thus most of the negatives will belong to the genotype *Rh*₂*Rh*₂, and *Rh*₂*Rh*⁺ and *Rh*⁺*Rh*⁺ will also be unagglutinated. As stated above, eight subjects negative to Br have been tested with the four antibodies in previous use. If Br is the hypothetical antibody η , then at least 85 per cent of Br-negatives should fall in the class containing *Rh*₂*Rh*₂, which constitutes no more than 15 per cent of the population. Of these eight cases, seven in fact fall in this class. None should fall in the group of classes which does not react to anti-*Rh*₂ or H—none in fact has been found to do so. The proportion of η -negatives should be 2.9 per cent, which is in fair agreement with the 4.1 per cent found for Br, a figure almost certainly including a few false negatives due to the weakness of the serum.

In order further to test this hypothesis, use was made of a family at present under genetic investiga-

tion, where two members are unambiguously *Rh*₂*Rh*⁺ and one *Rh*₂*rh*. The former are both Br-negative and the latter Br-positive. These genotypes were formerly serologically indistinguishable.

The genotypes of strong and weak reactors respectively show that the Br reaction is stronger where two Br-positive genes are present than where there is only one. In showing this single- and double-dose effect, Br resembles *St*^{2,3}, the other antibody known to agglutinate *Rh*-negative cells.

There can thus be little doubt that Br is identical with η , but genetic studies are continuing which should further confirm their identity. The chief practical value of the serum will lie in distinguishing between the genotypes *Rh*₂*Rh*₂ and *Rh*₂*rh*, the only common ones not distinguished by formerly known sera. The distinction is especially important in the fathers of erythroblastotic babies, since the *Rh*₂*Rh* men will have a much smaller chance of begetting healthy offspring than will *Rh*₂*rh* men. The discovery of this serum following soon after Race's discovery of the gene *Rh*₂^{3,4} emphasizes the value of Fisher's theory as an instrument of prediction.

This work would not have been possible without the help of the late Dr G. L. Taylor, who carried out most of the genotyping and gave me much very useful advice. Just before his untimely death, he was engaged in testing the serum against known genotypes and he appeared to have reached full agreement with the conclusions here stated. I am indebted to facilities for this work and much valuable assistance to Dr. H. F. Brewer, Prof. R. A. Fisher, Mr. R. Hudson and Dr. R. R. Race. My thanks are also due to Prof. R. V. Christie for the opportunity of investigating the patient concerned.

A. E. MOURANT

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¹ See Race, *Nature*, 153, 771 (1944).

² Race and Taylor, *Nature*, 152, 300 (1943).

³ Race, Taylor, Boorman and Dodd, *Nature*, 152, 563 (1943).

⁴ Murray, Race and Taylor, *Nature*, 155, 112 (1945).

Anti-*Hr* Serum of Levine

In 1941, Levine¹ in New York described a rare type of anti-*Rh* serum which was called anti-*H*. This antibody was found in the serum of an *R*⁺ positive mother of an erythroblastotic infant. Unfortunately, the weakness of the antibody did not allow the genetics of its corresponding red blood cell antigen to be worked out.²

In 1943, a powerful antiserum now called *St* was found in England and the genetics of the antigen which it recognized were worked out.^{3,4,5,6} Anti-*E* and *St* sera were alike in that they both reacted with *Rh*-negative and with at least the majority of *Rh* cells but here the similarity ended. Wiener, however, has categorically stated that they are the same antibody.⁷ A powerful example of anti-*H* serum has now been found and has recently been described by Waller and Levine.⁸ From the description it is quite clear that anti-*H* and *St* are not the same antibody. Waller and Levine say "in tests with potent anti-*H* serum all the *Rh*₁*Rh*₂ bloods gave negative reactions. About 60% of *Rh*₁ bloods of white individuals and almost all coloured individuals tested possessed the *H* factor." The original serum and three identical sera in our collection c

react with all Rh_1Rh_2 bloods. It is a striking coincidence that the percentage of positive reactions in the Rh_1 group corresponds exactly with the percentage which we can recognize by means of St serum to belong to genotype Rh_1rh , and it seems highly probable that this potent anti- Hr serum agglutinates the Rh_1rh fraction of the Rh_1 group. If this is so, it must react with only a single dose of an St positive gene, and the failure to agglutinate Rh_1Rh_2 cells cannot be attributable to the presence of only a single St -positive component, namely, Rh_2 .

It is interesting to compare the observed reactions of this potent anti- Hr serum with those predicted for the hypothetical antibody δ which Fisher's formulation anticipated⁶

Genetic structure in Fisher's scheme	Rh -negatives cde	Rh_1Rh_2 CDe	Rh_1 blood of white individuals About 60 per cent Rh_1rh and 40 per cent Rh_1Rh_1 CDe	Rh_1Rh_2 CDe
Observed reactions of anti- Hr (Levine)	+	-	+ with "about 60%"	-
Predicted reactions of δ (Fisher)	+	-	+ with Rh_1rh (60 per cent)	- with Rh_1Rh_1 (40 per cent)
Observed reactions of St (or γ)	+	+	+ with Rh_1rh (60 per cent)	- with Rh_1Rh_1 (40 per cent)

The hypothetical δ reacts with δ St (or γ) reacts with c

It was realized when Fisher proposed his scheme that if the antibody δ were encountered, it would be easily distinguishable from γ because the former would fail to agglutinate Rh_1Rh_2 cells.

The finding by Levine of an antibody possessing the characters of one predicted in Fisher's formulation of the genetics of the Rh blood groups greatly increases the probability that this formulation represents the actual state of affairs. That St serum and Levine's anti- Hr serum contain quite different antibodies is now certain, both react with Rh -negative blood, but with different components in its antigenic constitution.

It seems probable that Levine and Wiener are working with different anti- Hr sera. Levine's powerful anti- Hr appears to be the predicted δ , while Wiener's is probably St (γ).

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Levine, in the "Yearbook of Pathology and Immunology", 509 (1941)

Levine, *J. Paed.*, 23, 6, 656 (1943)

Race and Taylor, *Nature*, 152, 300 (1943)

Race, Taylor, Boorman and Dodd, *Nature*, 152, 563 (1943)

Race, Taylor, Cappell and McFarlane, *Nature*, 153, 52 (1944)

Race, *Nature*, 153, 771 (1944)

Wiener, Davidsohn and Potter, *J. Exp. Med.*, 81, 1, 63 (1945)

Waller and Levine, *Science*, 100, 453 (1944)

With the complete set of six antibodies now apparently discovered, the recognition of rare genotypes will be immensely easier. All the homozygotes of the seven known allelomorphs can be distinguished unambiguously, and nine of the heterozygotes, namely (omitting h 's), R_0r , R_0R_2 , R_0R_1 , R_2R'' , R_2R_2 , $r'r$, R_1R_2 , R_1R' . Three pairs of heterozygotes are indistinguishable

R_0R''	R_0R'	R_0R_2
R_2r	R_1r	R_1R_2

These leave little practical doubt, since in each case the genotype printed below is about one thousand times more frequent than that above.

Three more heterozygotes are capable of confusion only with a heterozygote involving R_y , which has not been discovered, and is unquestionably very rare.

R_yR_2	R_yR_1	R_yr
R_2R''	R_2R'	$R'R''$

It is among these that R_y may be looked for.

Finally, a group of three known genotypes, and one involving R_y , should react positively with all six reagents. These with their approximate frequencies in the British population are shown below.

R_1R''	R_2R'	R_2r	R_0R_y
0.8%	0.3%	0.4%	very rare indeed.

Thus it is only among these last that genotype recognition will have to rely on pedigree evidence. The interpretation of pedigree evidence also will now be greatly facilitated.

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An Unsuspected Relationship between the Viruses of Vaccinia and Infectious Ectromelia of Mice

It has been observed that emulsions in saline of the lesions produced on the chorioallantois by the virus of infectious ectromelia of mice have the capacity of agglutinating fowl erythrocytes. As is the case with vaccinia virus preparations¹, only about 50 per cent of individual fowls provide susceptible cells. Cells susceptible to one virus are susceptible to agglutination by the other. Agglutination by infectious ectromelia virus is inhibited by anti-vaccinal immune serum from calves.

The possibility of the infectious ectromelia virus being contaminated with vaccinia virus can be excluded, first by the completely different appearance of the lesions produced by the two viruses on the chorioallantois, and secondly by the fact that liver and spleen emulsions from mice dead of infectious ectromelia give a similar agglutination of susceptible but not of insusceptible fowl cells.

Using a technique similar to that commonly used for haemagglutination work with influenza virus, the titre of a stock membrane emulsion of ectromelia virus (each chorioallantois ground with 1 ml. of saline) is about 1×10^2 . The same emulsion titrated on the chorioallantois gives approximately 1.2×10^7 specific pocks per ml. This corresponds closely to the relationship found between the results with the same two methods of titration of vaccinia virus. Preliminary work suggests that a soluble product rather than the virus itself is responsible for the haemagglutination.

Although the two viruses differ sharply in host-range and type of lesion produced, their physical qualities agree closely, and there seems to be no adequate reason why our findings should not be taken at their face value as indicating that infectious ectromelia is the murine representative of the mammalian pox diseases.

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¹ Nagler, F. P. O., *Med. J. Australia*, 1, 281 (1942)

Effect of Adrenaline Solutions on Oat Roots

A SOLUTION of adrenaline, which is a catechol derivative, oxidizes in the presence of air and much more readily when some phenolases¹ are present. Solutions of adrenaline in tap water can inhibit the growth of oat roots in the concentrations indicated below

Concentration of adrenaline Per cent growth value	0.001 M	0.0005 M	0.0001 M	0.00005 M
	59.4	75.8	83.8	97.3

In addition to the effect on growth as measured by extension of roots, certain effects on cell development are of note. After forty-eight hours growth in the more concentrated solutions, it was observed that the root cap, when viewed by reflected light, was jet black and by transmitted light dark brown in colour. Under the microscope the youngest part of the root was still light, and the crest of dark root-cap cells was an excellent demonstration of this tissue.

At the root base and extending down to the region of cell expansion, the piliferous layer was seen to be stained dark brown and the root hairs remained small or undeveloped. In addition, the normal expansion of the piliferous layer had been prevented so that splitting of this tissue had occurred exposing the relatively unstained underlying tissues.

It was observed that the cell walls of the piliferous layer were stained and often the outer wall of the exodermis, this latter tissue apparently performing its classical role as a selective barrier to substances in solution. The staining was almost certainly due to the more complete oxidation of the adrenaline by a phenolase from the root cells. Tests for oxidase in normal 48 hours old roots showed that with Nadi reagent a deep blue colour developed rapidly in the root cap and root hairs and in the root generally. In the presence of peroxide the catalase of the root caused a rapid evolution of oxygen.

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¹ Martin, G. J., Ichniowski, C. T., Wisansky, W. A., and Ansbacher, S., *Amer. J. Physiol.*, 136, 66 (1942)

Control of the Potato-Root Eelworm *Heterodera rostochiensis* Wollenweber, by Allyl Isothiocyanate

MORGAN¹ was the first to report that few eelworm cysts are found on the roots of potato plants grown together with white mustard in pots of soil infested with the potato-root eelworm. Afterwards² it was shown that root excretions from potato plants mixed with those from white mustard seedlings will no longer stimulate the emergence of eelworm larvae from the cysts, this effect is also produced by black mustard, perhaps by cress, and, by certain solutions of allyl isothiocyanate, the mustard oil of black mustard seed³. Field trials with white mustard as green manure were a failure^{4,5}, due, it has been suggested⁶, to the difficulty of applying the excretions in sufficient quantity in the field, the results with allyl isothiocyanate suggested that these difficulties might

be overcome, and a small-scale field trial during 1944 gave promising results.

The mustard oil, on granular peat, was applied to the potato drills at the time of planting. Treated plants were superior to the various types of control throughout the season, and the difference became more pronounced as the season advanced. Yields were about 100 per cent above controls and the differences were statistically significant.

This is not the first occasion on which isothiocyanates have been used in combating eelworm. Smedley⁷ found the phenyl form to be very toxic to the eggs in the cysts, and used it in an extensive field trial, apparently unaware of the early work with white mustard and of the possible connexion of isothiocyanates with the response of larvae to potato root excretions, the oil, adsorbed on to talc, was applied all over the treated plots some time before planting. Comparison of the results of my experiment with 160 plants with those from an extensive field trial is somewhat presumptuous, but the results are very different. Application of phenyl isothiocyanate at the rate of 2 cwt. per acre increased the yield by 35 per cent, smaller dressings were ineffective. On the other hand, allyl isothiocyanate at the rate of only 0.1 cwt. or about 11 lb. per acre increased the yield by 100 per cent, and this isothiocyanate is also far cheaper. It remains to be seen whether the greater effect of the latter is due to the method of application, which takes account of the 'interaction' between mustard oil and potato root excretion, or whether it is due to difference in the properties of the substances.

A detailed account of this work will be published elsewhere.

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¹ Morgan, D. O., *J. Helminth.*, 3, 185 (1925)

² Triffitt, M. J., *J. Helminth.*, 8, 19 (1930)

³ Ellenby, C., *Ann. Appl. Biol.*, in the press

⁴ O'Brien, D. G., and Prentice, E. G., *Scot. J. Agric.*, 13, 415 (1930)

⁵ O'Brien, D. G., *Bull. W. Scot. Agric. Coll.*, No. 2 (1931)

⁶ 'McM.' *Imp. Bur. Agric. Parasitol. Notes and Mem.*, No. 6 (1931)

⁷ Smedley, E. M., *J. Helminth.*, 17, 31 (1939)

Use of Calomel on Onions

THE observations of Dr J. R. Boorer on the control of onion white rot (*Sclerotium cepivorum* Berk.)¹ are very interesting. A fairly extensive experience in the use of mercurous chloride for onion seed treatment under field conditions has led me to believe that the use of this substance may have a wider significance than is realized.

A particular case may be noted. During 1943 and 1944, I had under observation plots of onion plants grown from seed which had received calomel treatment at the rate of $\frac{1}{2}$ lb. per lb. of seed. In these plots I was surprised to see what appeared to be a marked degree of control of eelworm (*Anguillulina dipsaci* Kuhn), and a marked improvement in the crop itself.

Laboratory tests using calomel in water are entirely negative so far as any lethal effect on eelworm is concerned, but Dr Boorer tells me that his opinion some lethal effect is not impossible when calomel is decomposed in the soil. If this is so, a further investigation confirms that some degree

control of eelworm may be obtained, and this in addition to the already established control of onion fly and onion white rot, it would seem that the use of calomel in respect of onion crops may be very valuable.

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Nature, 155, 241 (1945).

Insect Epicuticle

Alexander, Kitchener and Briscoe^{1,2} have shown that the desiccation of many insects caused by inert dust insecticides is due to adsorption of the epicuticle wax film, which becomes discontinuous and allows of increased loss of water through the cuticle. Further, Wigglesworth^{3,4} has demonstrated abrasion of the wax film and increased evaporation of water caused by the application of an inert dust. It is evident, however, that insects differ considerably with regard to the epicuticle, for nymphs of *Rhodnius* are unaffected by adsorption but are susceptible to abrasion³, whereas *Tenebrio* and other larvae are more susceptible to adsorption than to abrasion¹.

Experiments with 'Neosyl' (a proprietary adsorbent silica dust) and carborundum powder show that *Sarcophaga* larvae are affected neither by adsorption nor abrasion, suggesting that they differ from both *Rhodnius* and *Tenebrio* larvae with regard to their epicuticular waxes. Histological examination shows that lipid substances are confined to a very thin layer at the surface of a thin (4μ) protein epicuticle. This surface layer differs from the remainder of the cuticle in being insoluble in cold concentrated hydrochloric acid, and may therefore be isolated as a thin membrane. Prolonged treatment with lipid solvents does not destroy the ability of this membrane to stain with Sudan Black B, and on account of its integrity after these treatments it is justifiable to regard it as a constituent layer of the cuticle, the outer epicuticle consisting apparently of a very stable lipo-protein complex. The bulk of the protein epicuticle does not stain readily with Sudan Black B, and is almost completely untanned.

A similar double epicuticle is present in the cockroach *Periplaneta*⁵, which also possesses an external layer of labile fatty substance⁶. It seems, therefore, that lipid substances may be associated with the insect epicuticle in one or more of a number of ways. They may be present as a readily removable surface layer; they may form a complex with the surface of the epicuticle so as to produce a distinct structural layer; and they may impregnate the whole of the epicuticle when this layer is tanned⁷. Variations in lipid distribution in the cuticle must clearly be taken into account as one of the many factors determining the effectiveness of an inert dust insecticide on different insects.

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Alexander, Kitchener and Briscoe, *Ann. Appl. Biol.*, 31, 143 (1944).

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Ramsay, *J. Exp. Biol.*, 12, 373 (1935).

Prior, *Proc. Roy. Soc.*, B, 128, 393 (1940).

Units for Degree of Vacuum

It has long been considered in this laboratory that when working in the field of medium and high vacua (pressures of 1 mm. mercury or less), the usual methods of referring to and recording the degree of vacuum are extremely awkward verbally and little less so when written.

There are a number of known systems of recording such pressures, the bar and the millimetre of mercury pressure (mm. Hg) and their subdivisions being most widely known, the micron being a subdivision of the mm. and the Torr, found in German practice, being a name given to the millimetre of mercury pressure as a unit of pressure. The millimetre of mercury pressure is almost universally used, but when subdivisions of this unit are used, recourse is necessarily made to either the negative index method or the decimal method of reference or recording. Thus, a pressure of, say, 2×10^{-5} mm. mercury may be written so, or as 0.00002 mm. Hg; both methods are lengthy to write, but verbally these expressions are even more unwieldy.

It is proposed, therefore, that a new unit be adopted, based on the logarithm of the numerical value of the pressure in millimetres of mercury. The reading in these units is, in fact, the logarithm of the pressure in millimetres, reduced to its all-negative form and multiplied by minus 10, this being similar to the method of measuring power ratios, etc., in decibels, the reference-level in this case being 1 mm. mercury pressure. A scale formed on this basis is very simple in use, both for written record and verbal reference, resulting in pressures of 10^{-1} , 10^{-2} . . . 10^{-6} mm. mercury, etc., becoming vacua of 10, 20 . . . 60 units, etc. The pressure of 2×10^{-5} mm. mercury referred to becomes a vacuum of 47 units. This system also leads to the logical result, that a 'higher' vacuum has a higher numerical value.

Such a system as that suggested could, of course, be based on any other unit of pressure, such as the bar or the standard atmosphere; but it is considered that the basic level of 1 mm. mercury pressure gives the working-range fitting best with current practice. Also a pressure of 1 mm. mercury is, in a most marked manner, the border-line between the field of medium- and high-vacuum work and the field of low-vacuum work, and there is seldom any overlap between the two fields. Consequently the fact that a pressure of greater than 1 mm. mercury would have a negative value on the suggested scale is of little disadvantage, since where work is consistently done in the low-vacuum range it is recommended that the scale of millimetres be adhered to.

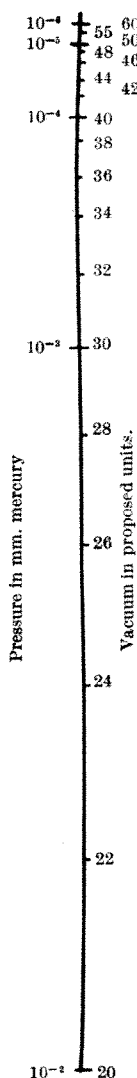


FIG. 1. SCALE OF TYPICAL MCLEOD GAUGE. FULL SIZE.

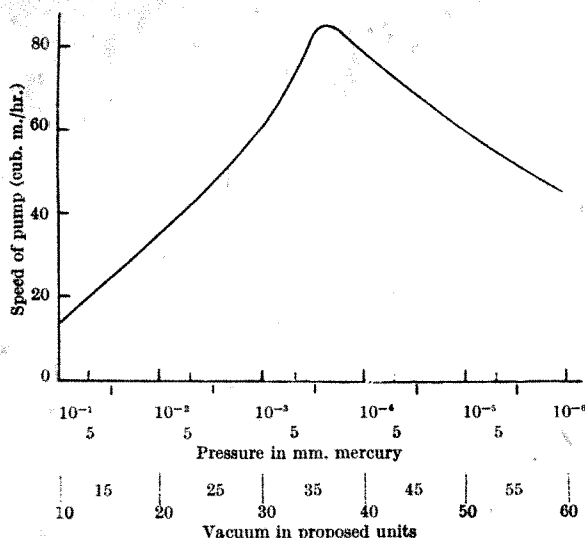


Fig. 2. SPEED OF 3-STAGE MERCURY DIFFUSION PUMP AT DIFFERENT VACUA.

A typical McLeod gauge scale, calibrated in the suggested manner, is shown in Fig. 1, and it may be seen that a more evenly marked scale than usual is obtained. Curves of pump performance, etc., may be plotted on ordinary squared paper, as shown in Fig. 2, and in both cases intermediate values may be more accurately interpolated than by the usual method.

No name has been given to this unit, as it has been found that reference to 'a vacuum of 47' is sufficient once the system has been established, but should this suggestion become more widely adopted, a suitable name should be found.

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Reflexion in a Non-Isotropic Medium

THE way in which the extraordinary ray transmitted by a calcite crystal infringes the laws of simple refraction is, of course, a commonplace and is mentioned in all text-books that deal with polarization.

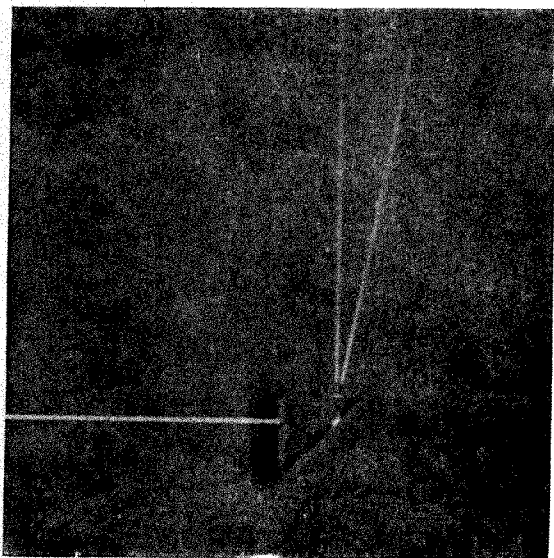


Fig. 1.

On the other hand, I have not yet found an explicit reference to the infringement of the law of the equality of the angles of incidence and reflexion.

Hence the accompanying photograph (Fig. 1), which illustrates one simple case, may be of interest. It shows the trace, on a sheet of paper, of a ray of unpolarized light incident upon the totally reflecting face of a prism of calcite cut in such a way that the optic axis is parallel to the incident beam. Two plane polarized rays are reflected. The one reflected normally is the ordinary ray, with the electric vector perpendicular to the plane of the paper, whereas the one reflected at an obtuse angle is the extraordinary ray with the electric vector parallel to the plane of the paper. In the latter case it is clear that the angle of incidence made with the totally reflecting surface is not equal to the angle of reflexion.

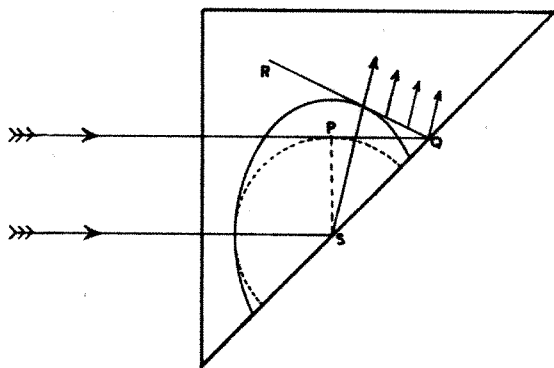


Fig. 2.

The result follows, of course, from the fact that, in the time waves take to travel from *P* to *Q* in Fig. 2, the extraordinary wave front that spreads out from *S* is an ellipse, and the reflected ray is thus propagated in the direction of the arrows or the tangent *QR*. After refraction this ray gives rise to the emergent ray seen in the photograph. The path of the ray thus calculated (using the accepted values of the ordinary and extraordinary refractive indexes) is in good agreement with the observed path.

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Action of Hydroxylamine on Polysaccharides Oxidized with Periodic Acid

BARRY¹ discovered that when a polysaccharide has been oxidized with periodic acid, the oxidation product on warming with phenylhydrazine yields glyoxalosazone. Thus, oxidized starch and cellulose are, theoretically at least, completely broken down into glyoxalosazone and erythrose phenylhydrazone while 1,3 polysaccharides, such as laminarin, being attacked only at terminal units by periodic acid have these oxidized terminal units completely removed by phenylhydrazine. It has now been found that a similar reaction takes place with hydroxylamine. Starch oxidized with periodic acid quickly dissolves in boiling water or absolute alcohol on addition of an alcoholic solution of hydroxylamine made by adding alcoholic potash to hydroxylamine.

hydrochloride until the solution is faintly alkaline. The solution becomes faintly acid as the starch dissolves and must be brought back to alkalinity by addition of more alcoholic potash. When the solution of the starch is complete, except for a small residue, the solvent is evaporated off, and ether will extract glyoxime from the residue after acidulation to set it free from its potassium compound.

Harriss² found that when the semiacetal of glyoxal, $\text{CHO}-\text{CH}(\text{OC}_2\text{H}_5)_2$, was treated with phenylhydrazine, an oily phenylhydrazone was formed, and when the mixture was heated, the acetal group also reacted with production of glyoxalosazone. An inspection of the formula for the oxidation product of starch with periodic acid shows that it is a polymerized semiacetal of glyoxal and erythrose, so that Barry's reaction is a special case of that of Harriss. Harriss does not report any attempt to form glyoxime from his glyoxalsemiacetal, but no doubt such a reaction would take place.

The yield of glyoxime from an oxidized starch has not so far been as good as the yield of glyoxalosazone, and has not exceeded about 30 per cent of that theoretically obtainable on the assumption that each unit of the starch has been oxidized. If, by further experiments, the yield can be made quantitative, the 'cleanness' of the reagent should make the oxime reaction a useful weapon for elucidating the structure of polysaccharides.

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Feb 24

Barry, V. C., *Nature*, 152, 537 (1943)

Harriss, C. D., *Ber. deut. Chem. Ges.*, 36, 1935 (1903)

Mechanism of Felting of Wool Fibres

THE theory of felting of wool in fabric form developed by Speakman and his collaborators¹ postulates that under the repeated application of pressure the unidirectional migration of wool, due to its scaly surface, is achieved by local extension and contraction of the fibres, and conditions which favour these processes promote milling shrinkage. In the course of the present investigations, a full account of which will appear elsewhere, it became clear that in felting the frictional properties of wool are as important, if not more so, than its extensibility and power of recovery.

The reason why the fibres always travel in the direction of their root ends in milling is that the action of wool is greater when rubbed from tip to root than from root to tip². The difference between the maximum and the minimum coefficient of friction has been termed by Martin³ the 'directional frictional effect', and it has been determined in the present experiments for a uniform sheet formed by several hundred wool fibres, with their scales all pointing in the same direction, against a horizontal polished

glass surface immersed in the appropriate medium. Some of the results, all relating to the same fibres, are given in Table 1, from which it is evident that the directional frictional effect changes with the pH of the medium in the same sense as does the felting power of wool.

These figures indicate, therefore, that the directional frictional effect is a very important factor in felting over this pH range, and in point of fact the recent communication of Whewell, Rigelhaupt and Selim⁴ partly confirms this conclusion, although they still maintain that in alkaline solutions the elastic properties alone determine the felting power of wool.

The same authors⁴, and Martin³, showed that the success of the anti-felting treatments with such reagents as chlorine, sulphuryl chloride, proteolytic enzymes, etc., depends on their ability to reduce the directional frictional effect of wool fibres. On the other hand, it has recently been claimed by Bari and Speakman⁵ that benzoquinone and mercuric acetate are the two substances which, in contrast, reduce the felting power of wool solely by modifying its elastic properties, which was also suggested earlier⁶ to be the cause of the diminished shrinkability of woollen fabrics dyed with heavy concentrations of certain dyestuffs.

We were not able to confirm the latter observations when the directional frictional effect of fibres treated with mercuric acetate, benzoquinone and 50 per cent Solway Green GS, respectively, was measured in soap solution using the present method, as distinct from the violin bow or the so-called lepidometer employed by Speakman and his collaborators. The results, which are summarized in Table 2, show clearly that in each case the anti-felting treatment has led to a very considerable reduction in the directional frictional effect.

TABLE 2*

Treatment	Maximum coefficient	Minimum coefficient	Directional frictional effect
Untreated	0.5333	0.4863	0.0470
Benzoquinone ⁵	0.6191	0.6121	0.0070
Untreated	0.5037	0.4634	0.0403
Mercuric acetate ⁴	0.6057	0.5957	0.0100
Untreated	0.2642	0.1837	0.0805
50 per cent Solway Green GS	0.4337	0.4047	0.0290

* The figures for each treatment refer, of course, to different sheets of fibres. The first two sets of results were obtained in 0.25 per cent soap solution, while the figures for the Solway Green GS treatment relate to 1 per cent soap solution.

Wool felts only to an insignificant extent in the absence of aqueous media, and this fact has been found to be also closely associated with the frictional properties of wool. Thus the directional frictional effect in ordinary air of air-dry fibres and of fibres immersed in lubricating oil has been discovered to be very low compared with the directional frictional effect of the same wool in an aqueous solution, as Table 3 shows.

TABLE 3

Medium	Maximum coefficient	Minimum coefficient	Directional frictional effect
Water	0.5000	0.4545	0.0455
Ordinary air	0.2060	0.1806	0.0254
Lubricating oil	0.3652	0.3453	0.0199

To sum up, these three sets of results indicate that (1) the variations in the felting-rate over the pH

TABLE 1

Medium	Maximum coefficient	Minimum coefficient	Directional frictional effect
Hydrochloric acid (pH 0.63)	0.4428	0.3559	0.0869
Soap (pH 9.87)	0.3559	0.3014	0.0545
Borax (pH 9.20)	0.4486	0.3968	0.0518
Sodium carbonate (pH 9.90)	0.5815	0.5321	0.0492
Water (pH 8.40)	0.5000	0.4545	0.0455

range in unbuffered solutions are directly related to the changes in the directional frictional effect, (2) apparently all known anti-felting treatments cause diminution in the directional frictional effect, although it is possible that the ability of some of these reagents to increase the resistance to deformation of the fibres contributes to their efficiency by rendering fibre entanglement more difficult, and (3) the low felting power of wool in non-aqueous media is due to their apparent incapacity to enhance the directional frictional effect.

It would appear, therefore, that the peculiar frictional properties are a principal, if not the principal, governing factor in the felting of wool fibres. The present evidence also suggests that their surface characteristics are of a more complex nature than hitherto supposed.

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Porritts and Spencer, Ltd.,
Barnford, Nr. Rochdale

¹ Speakman and Stott, *J. Text. Inst.*, **22**, T339 (1931) Speakman,
Stott and Chang, *J. Text. Inst.*, **24**, T273 (1933) Speakman,
Menkart and Liu, *J. Text. Inst.*, **35**, T41 (1944)

² Monge, *Ann. Chim.*, **6**, 300 (1790)

³ Martin, *J. Soc. Dyers and Col.*, **60**, 325 (1944)

⁴ Whewell, Rigelhaupt and Selim, *Nature*, **154**, 772 (1944)

⁵ Barr and Speakman, *J. Soc. Dyers and Col.*, **60**, 335 (1944)

⁶ Liu, Speakman and King, *J. Soc. Dyers and Col.*, **53**, 183 (1939)

Rontgen Centenary

PROF J. A. CROWTHER in his interesting article on "Rontgen" writes as follows: "The use of X-rays in the treatment of disease has scarcely made such satisfactory progress as its use in diagnosis." With Rontgen's first skiagram, radio-diagnosis was born, but what *a priori* reasons were there for supposing that X-rays would have any therapeutic value? None at all I think, yet some courageous few entered the field of exploration, and can anyone say that the results have in the circumstances really been unsatisfactory? Thirty-five years ago, all the beds in the Cancer Wing of the Middlesex Hospital were occupied by inoperable cases of cancer, there was no treatment except an almost superhuman kindness. In 1939 there was not one among the 92 patients in those wards who was not receiving active treatment, and for the great majority of them the treatment was by means of X-rays and radium. Though it cannot be claimed that these agents are a cure for cancer, the development of radiotherapy can scarcely be called unsatisfactory.

Prof Crowther says later on in the same article, "The action of X-rays on tissue cells, whether healthy or diseased, is, it must be understood, always destructive." But is it so? Are the haemostatic action of X-rays, their power of producing a lymphocytosis, their resolution (not destruction) of scar tissue, their action in regenerating bone, their excitation of the bone marrow to unusual activity, their temporary hold-up of mitosis, their enhancement of the mutation-rate, are these all to be labelled as destructive?

Treatment by means of X-rays and radium is a subject in which we do well to think in a rather less restricted manner than Prof Crowther's article suggests.

SIDNEY RUSS

Barnato Joel Laboratories,
Middlesex Hospital,
London, W 1

PROF RUSS does well to be jealous on behalf of a subject which he has made peculiarly his own. I can assure him, if assurance is needed, that my admiration of the magnificent work both in the way of treatment and research which has been, is being, and will with ever-increasing success continue to be, done in our radiotherapy departments is no whit the less than his own. I am only surprised that anyone who has read carefully the whole paragraph of which Prof. Russ quotes the opening sentence should doubt it. "Unsatisfactory" is Prof. Russ's word not mine.

As regards my poor word "destructive" with which Prof. Russ quarrels, it all depends on whether one considers the immediate action of the radiation, or the long-distance results of the action. To take only the case of the production of mutations, which is one which we are just beginning to understand, the primary action of the X-radiation is to break a chromosome chain at two different points. This, of course, gives Nature its chance to arrange the pieces in a different order, nevertheless, the breaking of a chain is essentially a destructive action.

J. A. CROWTHER.

University of Reading

Problems of Nomenclature

I HAVE read with much interest the discussion in *Nature* of December 30, p. 812, and wish to add a few suggestions to those there given. In the first place, it is highly desirable to have a single code of nomenclature for plants and animals. The problems are the same in both cases, and the existing codes are so much alike that a very moderate amount of revision would be necessary to secure uniformity. There are two matters which cause confusion, and should be dealt with.

(1) *Nomina seminuda*—names which have been introduced in an informal manner, without proper descriptions, but have been taken up because they could be interpreted in the light of subsequent researches. It would be a dangerous policy to rule that names poorly supported by descriptions should be rejected, but when there is nothing which will distinguish the species, and only subsequent studies of the fauna indicate by the locality what was referred to, the name should be rejected.

(2) Names proposed as of lower than specific rank. It should be ruled that subspecific names have the same validity as specific, that is, if a form is proposed as a subspecies, but later raised to specific rank, the subspecific term should be used. This is the usual practice, at least in zoology, but the botanists have mixed subspecies and individual variation under the designation 'variety', and it is not always easy to determine what the author had in mind. I would be well to take the lists of so-called varieties and separate those names which were really intended for what zoologists call subspecies, rejecting the others as invalid for use as species names.

In such ways a good many really needless changes might be avoided. A very desirable reform in botanical writings is the dropping of the name of the author of the combination in ordinary references to plants. Such names are scarcely ever cited in zoology, and I cannot recall an instance in which their omission has caused any inconvenience. The botanical practice wastes a lot of printer's ink and paper.

T. D. A. COCKERELL

Palm Springs,
California

SCIENCE MASTERS' ASSOCIATION ANNUAL MEETING

THE annual meeting of the Science Masters' Association was held in the Science Department of the City of London School during April 9-11.

The presidential address by Mr C L Bryant, late of Harrow School, and now, in his own words, of Ferranporth Youth Club, dealt with "The Impact of Science on Human Beliefs". The theme was worthy of one who, for nearly forty years, has served the Association faithfully and well. Christian missions are criticized because they uproot the faith of the natives without planting anything more suitable in its place. Science is doing that here and now. Until about fifty years ago, men believed, more or less, what the Churches told them. Now, for the most part they believe in nothing at all, not even in science, except as a provider of luxuries. This is largely because there is no background of philosophy to the science which is commonly taught in schools. Many of the Churches are hampered by creeds in which minor and debatable points are magnified into articles of belief. It is difficult for a scientific layman to discuss such matters with ecclesiastics. In the interests of truth the barriers should be broken down, and Mr Bryant pleaded for an approach between science and religion for (as we have recently seen) "where there is no vision the people perish". A group of members under Mr Bryant's leadership is to tackle the problem.

"The Social Relations of Science" was the title of the Science and Citizenship Lecture given by Mr J G Crowther, of the British Council. Mr Crowther traced the development of scientific research from the small scale activity before the War of 1914-18 to its present highly organized state, and outlined the consequent revolutionary changes in the place of science in the life of mankind in the last twenty years, and foreshadowed the equally great developments to be made in the next twenty years. Where are the men of science to come from to stimulate the application of science to many aspects of life in Britain? That is an educational problem. One of our chief tasks is to use the ability and enthusiasm of men of moderate ability much more efficiently than at present. In the education of such men the science master should be given every encouragement and material assistance, and such education should include a thorough study of the relation of science to other human activities. The men we need should be "statesmen of science" who approach the problems of humanity with the knowledge and understanding of statesmen, statesmen who approach them with knowledge and understanding of science.

A large audience was privileged to hear Sir Alexander Fleming describe his discovery of penicillin and the subsequent researches which led to its manufacture and chemical use. By means of an excellent series of lantern slides he led his audience through years of patient researches with a clarity of exposition that enabled each to feel the thrill of discovery. He described the work of the chemists in isolating the pure substance and the skill with which they overcame the major obstacle of its instability. No written account could do justice to a lecture which combined lucidity with dry humour and conversational intimacy.

Mr J McG Bruckshaw, of Imperial College, spoke on "Physics and Economic Geology" and gave a clear outline of the application of physics to the

problem of locating mineral deposits. Mr F W Cuckow, of the National Physics Laboratory, gave a fascinating account of the development and scope of the electron microscope, members enjoyed the speaker's intimate style and an excellent series of lantern slides. Mr R Maitland dealt with the chemistry of plastics, including an account of the replacement of carbon by silicon in the giant molecule. Mr C Bibby, education officer, Central Council for Health Education, talked eloquently on health education through school biology. The importance was stressed of distinguishing between habits which were the disciplining of natural functions and those aesthetic habits which were really habits of civilization.

A film show and discussion was held in the Ministry of Information theatre. Mr Arthur Elton, president of the Scientific Film Association, opened by speaking on the scope and limitations of the science teaching film. Scientific films of a suitable nature were few, and he thought that it was the duty of the teaching profession to lay down their policy for films in collaboration with the Scientific Film Association—the kind of films they wanted and for what age-groups. Science films, including the "Transfer of Power" which was produced and directed by Arthur Elton and Geoffrey Bell, were shown. Mr Geoffrey Bell discussed the film critically in a short talk on the making of a film. He stressed the need for careful research and script, good production and skilful editing, and invited the co-operation of members in helping to make good films. Mr W Farr, head of the Central Film Library of the Ministry of Information, spoke on the distribution of films. He hoped to see a Central Film Library linked with a number of local libraries—possibly twelve regional libraries dealing with free distribution of educational films to schools. Many members took part in the subsequent discussion. It was agreed that the best equipment for a school was one sound projector for use in the main hall plus one or more smaller silent machines for classroom use. A plea was made for using teachers not only in suggesting titles and the contents of scripts but also in the production of films and in getting better commentaries. The various types of films needed—historical, revision, etc—were discussed and the relative advantages of film and film strip assessed. Members were pleased to learn that the Education Section of the Scientific Film Association were engaged in preparing lists of suitable films and of the offer of Imperial Chemical Industries, Ltd, to produce scientific films for purely educational purposes.

A general discussion on the role of science in the future educational system was opened by Mr A W Wellings (Leamington College) and Mr D H J Marchant (Ilford County School). Mr Wellings, after examining the criticism of existing science teaching, stressed the great opportunities for the Association to see that, within the general educational framework provided under the new Act, science teaching plays a vital part in preparing pupils for the difficult and exciting job of living in a rapidly changing world. He pleaded for emphasis on the adventure of science, and for an alteration in technique, and a new attitude, so that the pupils get a better idea of the way in which science affects human activities and progress at every point, and can be led to realize that the problems created by science will be, in part, theirs to solve. He gave suggestions how this could be attempted, including a plea for a re-orientation of chemical studies, so that they could

be taught from the point of view of natural resources Mr Marchant dealt with the content of science courses. He advocated general science for all types of school, but emphasized that, although the course should cover a fairly wide field, whatever is taught must be science. He offered valuable suggestions on the elimination of irrelevant matter and on the economy of time and effort by presenting subjects with due consideration of the stage best suited to the difficulties. In developing theories, the tempo should not be that of research workers but accelerated in proportion to the richer background of fact which may now be assumed. Syllabuses should be planned concentrically so that general science and its possibilities for good could be worked out. Many members made valuable contributions to the discussion. Practical points such as the time allocation for science teaching (where the subject is taken to two credit stage in the School Certificate the allowance should be the same as for two separate science subjects), laboratory equipment, the relation between pre-school certificate work and post-school certificate studies, and courses for teachers. A plea was made for a fundamental approach so that science can be seen in proper perspective in the whole education of the future man. It was interesting to note, as distinct from pre-war discussions, that members seemed to assume that it was general science, and not separate science subjects, to be discussed.

The Members' Exhibition, though smaller than in recent years, was up to its usual high standard, and visits were made to hospitals, newspaper offices, the General Post Office and other places of scientific interest.

MARINE AND OTHER BIOLOGICAL LABORATORIES

By PROF. J. H. ORTON
University of Liverpool

DURING the war years, there have been a number of communications in *Nature*¹⁻⁴ on marine biological laboratories. It is possible that a review of these may be useful at the present time.

Great Britain

For many decades the Marine Biological Laboratory at Plymouth has been the centre of fundamental marine biological research in Great Britain, it has been the Mecca of zoologists from most British and many foreign universities. The chief reasons for the success of Plymouth are as follows. First, the abundance and variety of the fauna, the constituents and biology of which have steadily been defined by a succession of naturalists. The Laboratory was also able to supply research material at all times. The accessibility of Plymouth from the situation of the older universities was also important. The policy of the director, which pervaded the staff, has always been to hold to the principle that visiting and other researchers must be supplied with whatever living or other material they needed for their researches, so far as it was in the power of the staff and station to supply it. The policy of the Council has been to attract the nascent generation of zoologists as students of courses in marine biology, including ship and shore expeditions, and so to display the attractions of the subject and the station, and bring

together researchers working on a variety of problems. Lastly, sustained and increasing support was given by governmental departments, and especially the Development Commission, to the Laboratory.

Thus, a visiting researcher knew from the published fauna list⁵ what animals—or plants—he could expect to get in a living condition, and also that he would be given every reasonable help to conduct his researches. In the circumstances, a great variety of workers was attracted to the station, and their publications⁶ show that investigations have been made over the whole range of biology, namely: morphology, systematics, embryology, growth, life-history, food and mode of feeding, digestion, general physiology, sex and breeding, variation and heredity, ecology, behaviour and mortality, as well as the more limited and special problems of marine biology.

With this perspective in mind, it is easy to understand the growing need of the newer universities—less conveniently situated to Plymouth than the older—for a laboratory in proximity to them where facilities for study comparable to those at Plymouth can be attained.

Marine biological laboratories have also been established at Port Erin (University of Liverpool), Millport (University of Glasgow), Cullercoats (University of Durham), St Andrews, Nigg (University of Aberdeen), Robin Hood's Bay (University of Leeds), the Government stations at Lowestoft and Conway, Lough Ine (University College, Cork) in Eire, while the Welsh universities are also requiring one at Bangor. There is undoubtedly scope of some kind for all these stations, if scope be defined as facilities for visiting researchers, for special marine biological researches and provision for student vacation courses. All these laboratories, except Lowestoft and Conway, differ from that at Plymouth in belonging to universities, and as such had to compete in pre-war years with other departments for the limited funds available, or be dependent upon external sources for existence, but as the external source was mainly the Development Commission (Advisory Committee on Fishery Research), which quite correctly gave its major support to the definitive research station at Plymouth, there was little financial support left for the university marine laboratories.

The question now arises what functions these laboratories are to serve in post-war years. In a long-term policy, are the prospects in marine biological research such as to justify the staffing of all these laboratories with research workers? If the staffs were provided, would they find an adequate outlet for their energies and careers, and also supply in a succession of personnel the needs for fishery and other research posts (including economic and industrial requirements) of Britain and the British Empire? The answers to these questions of policy are not simple. If we look no further ahead than twenty years, probably the answers can all be given in the affirmative. There is, however, need for caution in their own interest against over-production of marine biologists in the post-war years.

There is no doubt that all the university marine stations can pay handsome dividends for facilities for research in general biology, and for that familiarization of senior and junior students with the problems of living marine animals and plants and their habitats which constitutes for most students the most attractive part of a biology course. To this end it is necessary to maintain at least skeleton staffs in all stations.

Thus the claims of the different university stations

staffing will depend upon the functions assigned to them, the propensities and personalities of the associated biology departments, the suitability of the stations for marine research, and the accessibility of the stations. As all the stations have a common objective, a definite degree of association is necessary for co-operation in common problems, but it is imperative that each station be given freedom to follow in the main its own line of fundamental research.

At most of the stations, including Plymouth, the main bearing of the research has been zoological or planktonic. Prof F E Fritsch³ has directed attention to the field of research in Great Britain on the benthic flora, and the need for combined work by biologists, botanists and physiologists on benthic problems. In this regard Fritsch points out that the larger staff at Plymouth—and, we can add, the cumulative knowledge of chemical and physical factors in the environment—points to Plymouth as the centre for this work. It has, however, perhaps been overlooked that an extensive bionomical survey⁷ has been made of the littoral algae in the Port Erin locality which, along with the similar survey⁸ of the fauna, places the Port Erin station in a strong position for further development.

Freshwater Biology

In the development of biology in the future it is clear that freshwater biology is of increasing importance. The development of the research station of the Freshwater Biological Association at Wray is following closely that of Plymouth in marine biology, and a glance at its publications⁹ shows that, besides pure freshwater problems, fundamental researches are being carried out as well as the training of senior students. Freshwater biology of great importance in the training of teachers in biology, since most teachers are located in inland situations and can more easily obtain living freshwater than marine material for their pupils, who, moreover, can collect the material for themselves. A bulk of biology students in most universities is destined to become teachers, therefore every university will in the future sooner or later need some kind of laboratory adjacent to the university where freshwater problems can be studied. Those universities in inland situations—and indeed many schools—may very well find a freshwater station more useful than a marine station, and a freshwater station can easily be improvised and equipped at a relatively low cost.

Colonial and Foreign Marine Biological Laboratories

The correspondence in *Nature*^{1,2} has shown that the training of marine biologists for tropical service posts, and research—and for general experience—a marine laboratory situated in the tropics would be of great value. There can be little doubt that most universities would welcome the opportunity of sending students and staff to such a tropical laboratory.

But so far the possibility of establishing a marine laboratory in a sub-polar locality has not been explored. It is likely that results of as great, or even greater, general interest would result from researches at such a station both on scientific and especially on very economic problems. We know very little of the living conditions of marine organisms in latitudes of extreme cold, as expeditions to those parts have

necessarily been mainly concerned in bottling their catches. New technique would be required and would be produced.

The Icelandic and White Sea fisheries present large economic problems, but general biology offers a wider and almost unknown field. The Danes, Russians (especially Gurganova¹⁰), as well as the British in the "Discovery" Investigations, have approached the problems, and would be interested in a station of this kind, which might indeed have an international character.

A site in Iceland or the east coast of Greenland, in addition to any the Russians may establish in the region of the White Sea, would, it is hoped, be accessible by air in post-war years, it would offer as great attractions as the tropics to adventuresome researchers.

¹ *Nature*, 152, 47 (1943)

² *Nature*, 152, 136 (1943)

³ *Nature*, 154, 144 (1944)

⁴ *Nature*, 154, 300 (1944)

⁵ *J Mar Biol Assoc*, VII, 2, 155 (1904 and 1931)

⁶ *J Mar Biol Assoc*, 15, 753 (1928)

⁷ L M B C Memoir XXX *Marine Algae* By M Knight and M W Parke (1931)

⁸ *Proc and Trans Linn Biol Soc*, 50, 5 (1936-37)

⁹ *Freshwater Biol Assoc Memorandum on Post-War Development*, 13 (1944)

¹⁰ *Explor des Mers d'U S S R*, Fasc 6, 5 (1928), and fifteen other papers

RIPENING EFFECTS OF EMANATION FROM FRUITS

BECAUSE the emanation from ripe fruits will accelerate the ripening of unripe fruits, it is in general undesirable to store together fruits of many varieties which have normally different rates of ripening, as the early ripening varieties may induce an undesirable hastening of the ripening processes in longer keeping types. It is of interest, therefore, to note that R M Smock¹ finds that the stimulating effects are greatest with emanations from apples past their climacteric, while the post-climacteric apples are themselves almost unaffected by emanations from ripe apples. Sometimes the emanation induces in adjacent fruits well-defined symptoms of ethylene injury², but *Penicillium expansum* growing in the store does not produce sufficient ethylene (or other stimulating substance) to affect the ripening of apple fruits.

Immature pears put into store straight after picking produce only very small amounts of ethylene, but their ripening and respiration can be stimulated by ethylene and then they themselves produce ethylene³.

So great can the stimulating effect of these emanations from ripe fruit be that in order to prevent, partially at least, accelerated ripening of the main bulk of fruit in a store, isolated early ripening individuals are frequently removed from store by hand picking. R M Smock⁴ finds, however, that oiled paper wraps are helpful in protecting apples against emanations of other apples, but that this procedure is not so effective as the removal of ethylene from the air of the store, and this removal can be effected by the use of brominated active charcoal, prepared by fixing 5 c.c. bromine on 40 gm of coconut shell charcoal.

¹ Smock, R M, *Proc Amer Soc Hort Sci*, 42, 128 (1943)

² Smock, R M, *Proc Amer Soc Hort Sci*, 40, 187 (1942)

³ Hans n, E, *Proc Amer Soc Hort Sci*, 43, 19 (1943)

⁴ Smock, R M *Proc Amer Soc Hort Sci*, 44 134 (1944)

FORTHCOMING EVENTS

Monday, May 7

ROYAL COLLEGE OF SURGEONS OF ENGLAND, at 4 p.m.—Prof F Davies "The Early Development of the Human Embryo" (Arris and Gale Lecture)

SOCIETY OF ENGINEERS (at Geological Society, Burlington House, Piccadilly, London, W 1), at 5 p.m.—Dr V E Yarsley "Plastics in Engineering"

ASSOCIATION OF AUSTRIAN ENGINEERS, CHEMISTS AND SCIENTIFIC WORKERS IN GREAT BRITAIN (ELECTRICAL AND MECHANICAL ENGINEERS GROUP) (at the Austrian Centre, 69 Eton Avenue, Hampstead, London, N W 3), at 7.30 p.m.—Mr M Littmann "Neuere Erkenntnisse über Hartmetall-Schneidwerkzeuge"

Tuesday, May 8

SOCIETY OF CHEMICAL INDUSTRY (CHEMICAL ENGINEERING GROUP) (joint meeting with the INSTITUTION OF CHEMICAL ENGINEERS) (Geological Society, Burlington House, Piccadilly, W 1), at 2.30 p.m.—Mr L W Needham and Mr S Lynch "The Use of Suspensions as Heavy Liquids"

QUEKETT MICROSCOPICAL CLUB (at the Royal Society, Burlington House, Piccadilly, London, W 1), at 7.30 p.m.—Mr F C Grigg "The Mechanics of Chromosome Movements"

Wednesday, May 9

ROYAL SOCIETY OF ARTS (at John Adam Street, Adelphi, London, W C 2), at 1.45 p.m.—Dr F M Walshe "The Treatment of Infantile Paralysis"

INSTITUTION OF ELECTRICAL ENGINEERS (TRANSMISSION SECTION) (at Savoy Place, Victoria Embankment, London, W C 2), at 5.30 p.m.—Mr J H Savage "Localization of Faults in Low-Voltage Cables, with special reference to Factory Technique"

INSTITUTE OF PETROLEUM (at 26 Portland Place, London, W 1), at 5.30 p.m.—Mr Alan D Maclean "Code of Electrical Practice for the Petroleum Industry"

Thursday, May 10

LINNEAN SOCIETY (joint meeting with the ZOOLOGICAL SOCIETY) (at Linnean Society, Burlington House, Piccadilly, London, W 1), at 4.30 p.m.—Miss E M Brown and Miss M F Sutton "Observations on the Population of some Emergency Water Supply Tanks, with a Description of the Life-History of *Corixa panzeri* (Hemiptera Heteroptera)", Dr R S de Ropp "Plant Tissue Culture, its Application in Botanical Research", Mr I H Burkill "Flies of the Family Empididae and Other Insect-Visitors to the Flowers of *Tamus communis*", Mr A L Poole "An Indigenous Induced *Phormium tenax* Forest Swamp in New Zealand"

INSTITUTION OF ELECTRICAL ENGINEERS (at Savoy Place, Victoria Embankment, London, W C 2), at 5.30 p.m.—Annual General Meeting

Friday, May 11

ROYAL ASTRONOMICAL SOCIETY (Burlington House, Piccadilly, London, W 1), at 4.30 p.m.

ROYAL INSTITUTION (at 21 Albemarle Street, London, W 1), at 5 p.m.—Sir Lawrence Bragg, F.R.S. "X-Ray Analysis—Past, Present and Future"

INSTITUTION OF MECHANICAL ENGINEERS (joint meeting with the HYDRAULICS GROUP and the MANUFACTURE GROUP) (at Storey's Gate, St James's Park, London, S W 1), at 5.30 p.m.—Mr F H Towler "The Modern Direct-Hydraulic System"

Saturday, May 12

INSTITUTION OF THE RUBBER INDUSTRY (MIDLAND SECTION) (Imperial Hotel, Birmingham), at 10 a.m. and 2 p.m.—Symposium on "The Physical and Chemical Breakdown of Rubber"

INSTITUTE OF PHYSICS (SOUTH WALES BRANCH) (in the Physics Department, University College, Cathays Park, Cardiff), at 2.30 p.m.—Prof W V Mayneord "The Use of Infra-Red Radiation in Medicine"

INSTITUTION OF MECHANICAL ENGINEERS (GRADUATE SECTION) (at Storey's Gate, St James's Park, London, S W 1), at 3.30 p.m.—Annual General Meeting Mr Peter Masefield "The Developments in the Design of Military Aircraft between 1918 and 1944"

APPOINTMENTS VACANT

APPLICATIONS are invited for the following appointments on or before the dates mentioned

SENIOR LECTURER IN MATHEMATICS—The Principal, Royal Holloway College, Englefield Green, Surrey (May 8)

WORKS MANAGER to control works in Surrey engaged on PRECISION INSTRUMENT PRODUCTION—The Ministry of Labour and National Service, Central (T and S) Register, Room 5/17, Sardinia Street, London, W C 2 (quoting C 2562 XA) (May 8)

CONSULTANT TO TIMBER RESEARCH LABORATORY, Transvaal Chamber of Mines, Johannesburg—The Ministry of Labour and National Service, Central (T and S) Register, Room 5/17, Sardinia Street, Kingsway, London, W C 2 (quoting F 3959 XA) (May 10)

TEACHER IN BIOLOGY—The Director of Education, Polytechnic, 309 Regent Street, London, W 1 (May 10)

AN ENTOMOLOGIST (Reference No F 3966 A) and a BOTANIST (Reference No F 3965 A) for the Government of Iraq—The Ministry of Labour and National Service, Central (T and S) Register, Room 5/17, Sardinia Street, Kingsway, London, W C 2 (quoting the appropriate Reference No) (May 11)

TEACHERS OF MATHEMATICS, of ENGINEERING SUBJECTS and HANDICRAFT AND DRAWING, at the Luton Technical College—The Director of Education, Shire Hall, Bedford (May 11)

TEACHER OF MINING SUBJECTS at Doncaster Technical College The Chief Education Officer, Education Offices, Doncaster (May 11)

ASSISTANT IN ADVISORY ECONOMIC SECTION (AGRICULTURAL) Leeds—The Registrar, University, Leeds (May 14)

LECTURER IN MECHANICAL ENGINEERING at Norwich City College The Director of Education, City Hall, Norwich (May 14)

PRINCIPAL OF LISBURN TECHNICAL SCHOOL—The Secretary, Cas Chambers, Lisburn, Co Antrim (May 14)

TEACHER OF CHEMISTRY, with special knowledge of Physical and Inorganic Chemistry, at Lancaster Technical College—The Division of Education Officer, Education Office, High Street House, Lancaster (May 16)

DEMONSTRATOR IN PHYSIOLOGY—The Warden and Secretary, London (Royal Free Hospital) School of Medicine for Women (May 1)

LECTURER IN SOCIOLOGY at the South-West Essex Technical College—The Chief Education Officer, County Offices, Chelmsford (May 1)

PRINCIPAL OF DARWEN TECHNICAL SCHOOL—The Education Officer, Darwen, Lancs (May 31)

ENGINEER TO THE CLYDE NAVIGATION TRUST—The General Manager and Secretary, Clyde Navigation Trust, 16 Robertson Street, Glasgow C 2 (marked "Engineer") (May 31)

ASSISTANT LECTURER and also LECTURER IN GEOGRAPHY—The Secretary, University, Birmingham 3 (June 2)

DIRECTOR OF THE ROWETT RESEARCH INSTITUTE—The Secretary, Rowett Research Institute, Bucksburn, Aberdeenshire (June 18)

LECTURER IN SOCIAL ANTHROPOLOGY—The Secretary, University of Edinburgh (Sept 30)

ASSISTANT LIBRARIAN—The Secretary, University, Aberdeen

LECTURER IN BACTERIOLOGY—The Principal, Studey Agriculture College

RESEARCH STAFF—The Director of Research, British Cotton Industry Research Association, Shirley Institute, Didsbury, Manchester, 20

LECTURER IN MINING at St Helens Municipal Technical College The Director of Education, Education Office, St Helens, Lancs

TEACHER OF ENGINEERING at the Crewe Technical College—The Director of Education, County Education Offices, City Road, Chester

ASSISTANT IN THE CIVIL AND MECHANICAL ENGINEERING DEPARTMENT, in the Portsmouth Municipal College—The Chief Education Officer

LECTURER IN EDUCATION, with special qualifications in the method of teaching Science—The Secretary, University, Birmingham, 3

LECTURER IN BIOLOGY at Stockwell College, Bromley—The Principal, temporarily at Watcombe Park, St Marychurch, Torquay

REPORTS and other PUBLICATION

(not included in the monthly Books Supplement)

Great Britain and Ireland

Proceedings of the Royal Irish Academy Vol 50, Section B, 1944 The Male Genitalia of the British Stigmellidae (Neptulid) (Lep.) By Dr Bryan P Beirne Pp 181-218 (Dublin Hodges Figgis and Co, Ltd, London Williams and Norgate, Ltd, 1944) 2s

University of London University College Annual Report, February 1944—February 1945 Pp 44 (London Taylor and Francis, Ltd, 1945) 1s

London Shellac Research Bureau Abstracts bearing on Shellac Research Literature for the period 1st January to 31st December 1944 Pp ii+6+vi Bulletin No 7 Determination of Volatile Matter in Lac By Dr B S Gidvani and N B Kamath Pp Technical Paper No 26 A Process for the Manufacture of Dewalac Lac By Dr B S Gidvani and N B Kamath Pp 26 Technical Paper No 27 Lac-Ethyl Cellulose Lacquers By N B Kamath and Dr B S Gidvani Pp 24 (London London Shellac Research Bureau, 1945)

Penicillin Pp 32+4 plates (London Therapeutic Research Corporation of Great Britain, Ltd, 1945)

Imperial Cancer Research Fund Forty-second Annual Report 1944-1945 Pp 32 (London Royal College of Surgeons, 1945)

Other Countries

Nigeria Annual Report on the Forest Administration of Nigeria for the Year 1943 Pp 36 (Lagos Government Printer, London Crown Agents for the Colonies, 1945) 2s

Brooklyn Botanic Garden Record Vol 33, No 4 Supplement to the Thirty-third Annual Report of the Brooklyn Botanic Garden January 1—June 30, 1944 Pp vii+195-236 (Brooklyn, N.Y. Brooklyn Institute of Arts and Sciences, 1944)

U.S. Department of Agriculture Circular No 717 Chemical Impregnation of Trees and Poles for Wood Preservation By B Wilford Pp 30 (Washington, D.C. Government Printing Office, 1944) 10 cents

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LOOKING FORWARD

THE announcement of the official cessation of hostilities with Germany overshadows all other considerations. As we have been frequently reminded, we are by no means at the end of our perilous journey, but we can at least rejoice soberly in the accomplishment of one stage of it, and that a stage which has been fraught with the direst danger. When we look back over the past six years, no one can but be amazed at the achievements of peace-loving peoples against an enemy who over a period of years devoted himself to preparations for war.

Much of our success has been due to the efforts of scientific and other professional workers, who were swift to respond to the call for their services. Throwing aside their normal occupations—in industry, the universities and elsewhere—even before the outbreak of war they put themselves individually at the disposal of the country. Through the Central Register, a most valuable body of information on the scientific and engineering man-power resources of Britain was voluntarily compiled, which has made possible the staffing of the large number of war-time factories necessitated by the scale and diversity of needs of modern war. Moreover, the general public has not been unaware of, or ungrateful for, the contributions made by science to the task of defeating the enemy, indeed, there have been times when it has been necessary to check public enthusiasm and to remind people at large that science alone could not achieve a decision. In the Press and in addresses in the Houses of Parliament and elsewhere, there have been many sincere tributes to the effectiveness of the application of scientific knowledge and methods in the most unexpected fields. The reason for this outburst of enthusiasm for science is clear enough, but it is a reflexion upon the general scope of education in Britain—and also upon scientific workers for their lack of missionary zeal—that such achievement should apparently come as a surprise to a majority of the people.

It may not be out of place even here to indicate very briefly some of the noteworthy advances in knowledge which have been brought to public notice during the War. Radiolocation and other developments in radio communication immediately come to mind, in spite of the fact that it has not been possible to publish much definite information on the subject. Happily much of the work in this field of electronics has obvious applications for the days of peace. The development of aeronautics, both as regards power-driven machines and gliders, has been equally striking. Aeroplanes of a size which would have been regarded before the War as possible but highly unlikely within several decades are now almost commonplace, and great fleets of a thousand or more operating as a unit are being used. But beyond great increase in size and speed of the individual machine and of the operational unit, there is a host of ancillary services, each of which can make a contribution to post-war progress. Air navigation, by night and by day, has become as precise as sea

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navigation, and both will benefit from the increasing sureness of radio communication. The significance of the enhanced power and reliability of internal combustion engines requires no emphasis, and the development of a new prime mover, the jet propulsion engine, though particularly associated in the minds of most people with the 'flying bomb', will have its place in the aerial transportation of the future. Meteorology has been amassing data the importance of which can only be surmised; it is sufficient to note that trans-Atlantic flights in both directions have become matters of routine.

In the medical field there have been equally noteworthy achievements. Turning again to problems connected with the aeroplane, it is noteworthy that much progress has been made in connexion with high-altitude flights. As regards more strictly medical matters, mention must be made of the extended use of the sulpha drugs, and also of the applications of penicillin; between them, there is little doubt that the sulpha drugs and penicillin have been the means of reducing substantially the number of fatalities from war wounds. Great progress has been made, as is usual in such times, in the surgery of war wounds, and also in the treatment of burns. Blood transfusion has been carried out on a scale never previously contemplated, and has led to much important new work on the constitution of the blood, the factors it carries and their significance in inheritance. Considerable importance is also attached to the discovery of new insecticides, of which D D T. is probably best known.

Food technology has also received a great stimulus. The drying of milk and eggs was carried out on a commercial scale before the War, but the cutting off of supplies of fresh eggs from the Continent, and the great curtailment of shipping space, have increased the traffic in the powdered products by an extraordinary amount, until they have become part of our regular rations. Valuable knowledge has also been acquired in the preparation of concentrated foods.

Perhaps more important still is the opportunity which enforced rationing has given of seeing that the nation, as a whole, has had available a diet which medical statistics have shown to be very satisfactory from the point of view of physical health. In this connexion it is interesting to note that, probably for the first time, certain imports have been deliberately regulated as to kind and quantity in accordance with scientific data derived from nutritional studies.

More purely social studies also come into the picture. The paucity of knowledge on population movements and their effects became evident on the outbreak of war, with the ill-conceived but well-executed evacuation of the children of London and other big cities. As a piece of organization the operations were successful, but too little attention was given to the human element, with the result that a steady drift back to the cities quickly set in. The transfer of industries to safer areas was more successful, perhaps of necessity, but brought in its train many difficulties which ought at least have been eased by deeper knowledge of social trends. The data thus painfully acquired will be of

considerable value to future studies of population movements and mass psychology. War-time studies of munition workers and others has also provided useful material in the field of health in industry, and has amply justified the investigations of the Industrial Health Research Board, which originated from similar investigations undertaken during the War of 1914-18.

Enough has probably been said to remind readers that many scientific developments of first-rate importance have taken place during the War. But it must not be imagined that we have any desire to extol war, or even to credit it with additions to knowledge. The developments referred to above were inherent in the progress of science, the War has provided almost unlimited financial support, increased opportunities and the stimulus of public interest born of the nation's peril.

Turning now to the immediate future, and even confining ourselves to strictly utilitarian considerations, there is still a multitude of tasks ahead for scientific workers, from the highest levels to the lowest. In these columns it is not so necessary to stress their part in promoting the well-being of the community, and in industry and commerce, though this is of high importance. We have in mind rather the problem of the control of Germany in the post-war world, and we stress the point because even men of science themselves may not realize the extent to which a just but effective control will depend on scientific knowledge and method. The multitude of problems should be approached in a scientific manner by assembling the data and determining action on the impartial consideration of the whole need not be emphasized. Even in the political field, there are problems of mass psychology on which scientific men should be able to provide valuable guidance. In the control of industry, the influence of the man of science and the engineer is more obvious. Indeed, it is not too much to say that without scientific knowledge it is impossible to devise adequate controls, and policy-making in this field must be largely in the hands of scientific men. Some of the possibilities were indicated in an article in *Nature* of April 24, 1943, p. 455, referring to the control of 'key' chemicals, and reference was made to the difficulty, for example, of effectively separating the fertilizer from the explosives industries.

Then again, adequate control of the manufacture of fine chemicals in Germany will be necessary. Some may go so far as to say that it must be suppressed, but it would be better to ensure that the undoubted abilities of German chemists in this field should be used, not for flooding other nationals' markets to the exclusion of local products and creating world-wide monopolies of strategic and commercial importance, but for the good of mankind. The problem is a difficult one, and should not be dismissed without careful consideration.

Even in the munitions industries it is only the final stages of the products that are specifically connected with war. In their engineering, metallurgical and chemical aspects, they are inextricably mingled with agricultural and other industries. Thorough appreciation of the scientific basis of these

industries is necessary in order to formulate measures control, and more than a superficial acquaintance with physics and chemistry will be required to supervise the controls imposed. Chemical industry should not be entirely suppressed, for that would not only lead to additional unemployment, directly and indirectly, but also to the increased dependence of many on imports, and that at a time when the most strain is being imposed on the United Nations to supply their own needs in the agricultural and industrial fields. Again the problem is an intricate one, which will require careful discussion in the light of all the known facts.

The fact that the Government has been asking for more recruits with various grades of scientific and engineering knowledge for service in Germany after the War in Europe ends indicates that there is appreciation in Government circles of the part that scientific men can play. There can be no question that their services, provided they are not unduly strained by the administrative and military machines, will be of vital importance in the control of Germany.

Enough has probably been said to show that scientific workers have played a full part in the prosecution of the War, and that they must be intimately concerned in the years to come in dealing with numerous problems arising directly out of it. In addition to their *ad hoc* activities, it is generally conceded that science must take an ever-increasing share in the promotion of peace-time industry, and that ample provision must be made for that form of research which is perhaps best described as the pursuit of knowledge for its own sake.

The broad outlines of the strategy and tactics of research in Great-Britain during the years to come are outlined in a series of six articles on "Scientific and Industrial Research" published in *Nature* last month, and the main points are worth repeating. Strategy is the premier consideration, for it must determine the general programme, and it will obviously involve decisions on policy at the highest levels. The whole educational system of the country involved, in that it will decide the quality of the personnel who will carry out research, while the nation must be able to appreciate the significance of the work scientific men do and the way in which they approach their tasks. No rigid dividing line should, indeed can, be set between so-called pure and applied research, and increased facilities should be made available for the interchange of personnel between the universities, industry and Government alike. The recent foundation of senior fellowships in science in the universities, where those appointed will combine research with a certain amount of teaching, is probably a most valuable step in the right direction. This leads inevitably to the consideration of the position of the universities in the post-war world. Expansion there must be, but local innovations would not appear to be needed; universities must continue to be, fundamentally, communities of teachers and students, where knowledge is sought for its own sake, as well as for its use as a preparation for a particular task or mode

of livelihood. In particular, they will be expected to provide opportunities for the development of the qualities required for leadership.

It is, of course, premature to attempt to foresee the optimum number of research workers in advance of the actual programme of research. But some consideration of subjects is not out of place. Thus it is already realized that both biology and geology will require many more trained workers than are at present available, and the universities will have to make corresponding preparations. Social biology is a relatively new and actively growing subject which will demand consideration. Re-allocation of research effort between the various sciences may become an urgent necessity, this will clearly involve machinery for the co-ordination of research in the universities and elsewhere. The British tradition favours evolution, and it is to be expected that existing institutions and methods, where they have proved successful, will be developed and extended. New institutions will obviously be necessary; but flexibility is of prime importance. The increase of State assistance to the universities must not be allowed to encroach on their independence. As regards research in Government institutions, there is at present insufficient correlation of effort between the various bodies, and there should be provision for associating it with advances in the fields of social science and economic science. Research carried out by industrial firms is more difficult to organize, but the suggestion from industry itself of a central co-ordinating office is worth careful consideration.

In any discussion of the future of scientific and industrial research, prominent consideration must be given to the improvement of conditions of service. By this is meant not salary alone, but also questions of status, publication of the results of research, superannuation, interchange of staff between university, Government and industrial institutions, and so on. Here the professional institutions can play a leading part, for they have among their members the varied knowledge and experience which will be invaluable in formulating codes of professional conduct and related matters (see also *Nature*, December 2, 1944, p. 693).

This cursory survey of the present achievement and future significance of science has ended, as it began, with the human element. This has been thought necessary, because it is on the personality, integrity and devotion of the man of science that so much will depend. Never has science stood so high in public esteem, never have the efforts of scientific men been so widely appreciated and acclaimed. Science has been accorded—and willingly accepted—a foremost place in the highest councils of the nations, it must continue in that place, and by its influence justify the faith the peoples have grown to have in it. The key to the present and the future is unremitting vigilance and purposeful activity. There must be no slackening of effort, no relaxation of standards. Rather must the present thanksgiving be a spur to additional exertion, in the sure knowledge that we are building on a tried and stable foundation a new and progressive world order.

MENTAL HEALTH IN WAR-TIME

The War and Mental Health in England

By Prof James M Mackintosh Pp v+91 (New York Commonwealth Fund, London Oxford University Press, 1944) 5s 6d net

THIS book does not pretend to be either a scientific or a medical treatise on the subject of mental health in England during the War. It is a collection of essays written in non-technical language describing the successive phases of the first four years of the second World War and giving an account of the author's impressions of the effect of war conditions upon the population.

It discusses the industrial worker, the new soldier, the housewife, food-rationing, the evacuation scheme and the child in war-time.

There is a general impression that war conditions are unfavourable to mental health and that this is indicated by an increased amount of recognizable mental illness in war-time. The prevalence of neurosis in the War of 1914-18, popularly termed 'shell-shock', and the argument that modern warfare, bristling with new dangers and, in any case, imposing privations of a greater or lesser degree of severity, will exert unaccustomed strain and cause mental breakdowns, are chiefly responsible for this impression.

Examination of the subject shows that the issue is more complex. In the first place, in 1922 the Army Council Committee reported that the name 'shell-shock' should be eliminated, that the War of 1914-18 produced no new nervous disorders but that they were the result of genuine concussion in a small proportion of cases, or the result of emotional shock (usually in constitutionally predisposed persons) in 80 per cent of cases, or the result of nervous and mental exhaustion, and that no psychoneurosis should be classified as a battle casualty any more than sickness or disease is so recorded. Most of the neuroses arising out of the War of 1914-18 were either anxiety states or hysteria. The findings of the Army Committee were fully confirmed at a conference which was held at the Ministry of Pensions in July 1939¹.

In the second place, 'neurotic incapacity', like other forms of disease, is greatly influenced by environment. It is well known that a man infected by tuberculosis—a disease sometimes associated with mental symptoms—may often lead an active and useful life, provided he lives under sheltered conditions and does work adapted to his physical capacity. Put such a man into competition with healthy labour or enlist him into the Fighting Services and he breaks down with his quiescent pulmonary lesion flaring up into activity. In the same way, many a soldier may be diagnosed as mentally ill or be discharged from the Army, who in peace-time would never have come under medical observation for mental aberration, although he may not have been in perfect mental health. As Dr Aubrey Lewis² has observed in discussing this subject:

"So there is in part a spurious rise, due to more systematic medical examination of the population, to more careful diagnosis, and to a change in the demands of the environment, converting a harmless anomaly into an incapacitating disorder. This applies, of course, with especial force to mental deficiency, so-called higher grades—i.e., 'dull and backward', 'feeble-minded'—will be detected and returned in the

statistics of a Service population, whereas they would have escaped attention under pre-war conditions."

It is undoubtedly true, on the other hand, that war brings out qualities of resilience and endurance which make for the preservation of mental health under the most adverse conditions. Before the War certain persons in authority were highly apprehensive of panic and nerve-storms in the congested areas of London when exposed to air-raids. No such disorder occurred. In colloquial language, "the people could take it." The War has inspired a feeling of corporate unity and service to the common weal which help to lessen the incidence of mental illness, and good morale has been shown under the strain of repeated and incessant aerial bombardment.

Another factor for consideration is that in the present War certain reforms have been instituted which are advantageous to mental health. To quote Dr Aubrey Lewis² again:

"If, for example, production committees, welfare managers, and factory medical officers have improved the mental as well as the physical health of workers, they partly counteract the adverse factors in war-time industry, which need no recapitulation. Having been instituted under the pressure of war needs, they may be laid to the credit of war even though the link is not essential."

Lastly, a most important factor is the general improvement in national health which has been secured to a considerable extent, at all events through the national health services, by 1939. This prevented not only physical but much mental disorder.

Dr Aubrey Lewis³ reports that air-raids have not been responsible for any striking increase in neurotic illness, indeed, crude figures from hospitals and outpatient clinics suggest a considerable drop. The incidence of such illness in fire-fighters and other workers in civil defence has been low. Mental disorders in England and Wales have diminished.

In the total number of persons suffering from notified mental disorder there was a decrease of 4,048 during 1941 and a decrease of 3,516 during 1942. The average annual decrease for the five years ended December 31, 1942, was 1,952, which contrasts with an average annual increase of 1,600 in 1934-38 (Twenty-ninth Annual Report of the Board of Control).

Suicides in Great Britain during the war years show a steady drop as contrasted with Germany where, according to the *Reichsgesundheitsblatt* for October 1942, there has been a rise in the suicide-rate in large towns.

The incidence of mental disease and ill-health in the Services has not been large, but there has been a great development of psychological and psychiatric work in these Services, and every endeavour has been made to eliminate misfits and to keep the fighting population both mentally and physically healthy.

Statistical and clinical evidence, on the whole, indicates that war conditions have lessened rather than increased mental illness. It is important to remember that the final chapters of the story have still to be told. "The amount of mental ill-health manifest during the war is not a safe index of what is really happening to the mental health of the community" (Lewis). The figures of the British Ministry of Pensions and those published in the

United States of America⁴ for mental disorders after the War of 1914-18 indicate that a high proportion of men and women affected eventually succumbed to mental illness as a result of prolonged war-strain.

Prof Mackintosh advocates greater attention to psychiatry in the medical curriculum and enhanced encouragement by the State of the psychiatric social worker. The difficulty here is that psychiatry embraces many schools of thought, it is by no means an exact science, and sometimes the patient treated by a fervent disciple of Freud has his mental illness aggravated rather than ameliorated. As Lewis² observes "I do not think we shall need cohorts of psychiatrists". But we do need general practitioners trained on sound lines in the social and psychiatric problems of their work and familiar with the mental aspects of organic disease.

Much mental illness has a physical basis and the converse statement is also true. In this connexion reference may be made to an interesting paper by Morris and Titmuss³, which discusses the rising mortality from peptic ulcer. The authors claim that the effects of heavy air attacks during 1940-41 resulted in, first, a sharp rise in mortality from duodenal ulcer which was closely followed by a similar movement in mortality from gastric ulcer. The circumstances were, at all events, associated. There is a constant interplay between physical and mental ill-health.

Work of this kind opens out fresh avenues of research into the nature of the relation between mental and physical disease, which is a much more hopeful line of investigation than speculative theories concerning repressions, obsessions and complexes.

Prof Mackintosh's book calls for little criticism. He makes too sweeping a statement on p. 7 when he observes that "pre-war Government policy did little to improve physique and nothing to uplift the mind". The work done by the Education and Health Ministries of Great Britain in physical training, in the provision of milk and meals in schools, in preventive medicine and in hygiene over a number of years preceding the War, had greatly improved the physique and nutrition of the school-child in comparison with the past. Nor had the question of the physique of the adolescent been ignored. The Board of Control was pursuing an enlightened policy towards mental disease, and considerable attention was devoted to the neuroses and the treatment of mental defectives. Indeed, Prof Mackintosh's own work both as a medical officer of health and as chief medical officer of the Department of Health for Scotland would alone indicate that pre-war Government was not unmindful of its responsibilities for physical and mental health.

These essays give a vivid historical picture painted in words with considerable literary ability. They emphasize the grit, self-control and determination of the English people when fighting for their national existence and they show how the nation, as a whole, acclaimed and responded to the inspiration of Mr Churchill's leadership. **ARTHUR S. MACNALLY**

POST-WAR NUTRITIONAL RELIEF IN EUROPE

Nutrition and Relief Work

A Handbook for the Guidance of Relief Workers. (Published by the Council of British Societies for Relief Abroad.) Pp. 111. (London, New York and Toronto: Oxford University Press, 1945.) 5s. net.

THE appearance of this little text-book is indeed opportune. Soon there will be at work in many European countries a large army of relief workers, both foreign and native, of whom very few can have had any previous experience of the job they have undertaken. As usual, a good proportion of these workers will be English-speaking, and for these this book in English, with all the relevant information and sound advice contained in its hundred pages, should prove a real companion and guide. The list of experts invited by the Council of British Societies for Relief Abroad to form a committee responsible for this guide book itself gives promise of a worthy production. The result is no disappointment.

The earlier chapters contain a simple but scientific account of the physiology of human nutrition, of the energy or calorie value, and the separate nutritive elements—proteins, fats, carbohydrates, minerals and vitamins—which must be included in an adequate diet, and further of the quantitative requirements for each of these dietary essentials. This is followed by a description in non-technical language of the signs which may indicate a state of partial starvation due to a lack of food in general, as well as of the symptoms which may suggest a specific deficiency of one or other of the essential nutrients, and of the variability of these symptoms as they may appear among different classes of the population—infants, children, and adult men and women. Tables are given which show the calorie value and composition of the chief foods, including their content of minerals and vitamins.

The remainder of the book, devoted chiefly to the technical aspects of nutritional relief, reveals the wide experience possessed by those who have compiled it. Sections are devoted to methods of dietary surveys, to storage and handling of foods, to camp equipment and emergency methods of cooking and serving meals.

A particularly interesting chapter deals with the food habits peculiar to the inhabitants of different European countries, situated, respectively, in the north and west, and south and east, and a useful table is given which shows the consumption of principal foods in these districts in periods both before and during the War. Here perhaps a little criticism of minor points and a few additions might be useful. In Italy, although consumption of other dairy produce may be low, it is the usual custom to take grated cheese with the almost daily meal of macaroni or spaghetti, the widespread use of garlic in cooked foods might also be mentioned. In Austria and some parts of southern Germany, the meat, usually eaten at the midday meal in all but the poorest households, most frequently takes the form of *Rindfleisch*—beef of poor quality which is stewed in the soup which precedes it and is rendered palatable by a variety of sauces, changed from day to day. The glossary of food and cooking terms in French and German might be enlarged with advantage and some alternative expressions given. For example, in South Germany and Austria milk curd is usually

¹ Ministry of Pensions. Neuroses in War-Time. Memorandum for the Information of the Medical Profession. Pp. 7. (London: H.M. Stationery Office, 1940.)

² Lewis, A. "Mental Health in War-Time", *Public Health*, 57, No. 3, 27 (1943).

³ Lewis, A. "Neurosis in England under War Conditions", *Lancet*, ii, 176 (1942).

⁴ Dayton, N. "New Facts on Mental Disorders" (Baltimore, 1940).

⁵ Morris, J. N., and Titmuss, R. N. "Epidemiology of Peptic Ulcer. Vital Statistics", *Lancet*, ii, 841 (1944).

known as *Topfen* and cream as *Obers*, in France, *blé* may signify wheat as well as other cereals, and corn or maize might be translated as *mats* or *blé de Turquie*. If the present translations of 'hunk of bread' were used, there would certainly be disappointment in a recipient led to believe he would receive a *tartine* or a *Butterbrod*.

If it must be admitted that the perfect relief worker, like the poet, is born and not made, it may also be admitted that less perfect specimens might be brought appreciably nearer in quality to the ideal, after a careful study of the information and advice contained in this unpretentious but valuable little book.

H. C.

THE HUB OF THE FUTURE WORLD

The Geography of World Air Transport

By J Parker Van Zandt. (America Faces the Air Age, Vol 1.) Pp viii+67 (Washington, D.C. Brookings Institution, London Faber and Faber, Ltd., 1944) 5s net

THE Brookings Institution was established in 1927 with the twin objects of "aiding constructively in the development of sound national policies and . . . to offer training of a super-graduate character to students of the social sciences". In pursuance of these objects, it initiated in 1943 a programme of economic research in aviation under the direction of Dr J Parker Van Zandt. The director has now prepared the introductory volume to a promised series, and he limits himself to outlining the basic setting of the world air transport problem.

The author points out the many erroneous ideas of the space relationships of the countries of the world which have arisen from the still all too common use of Mercator's projection for wall maps and atlas maps of the world. Curiously enough, much that he has to say may be novel to the American public, but is actually what has been taught in British schools for the past four decades. Americans may be shocked to find that Chicago is nearer to Istanbul than to Buenos Aires, and that Los Angeles is nearer Moscow than to Rio. "Most of the world that matters lies in one hemisphere . . . 94 per cent of all the people and 98 per cent of the world's industry", and the centre of that hemisphere is in western Europe. Actually London is used as the centre of what is called the "Principal Hemisphere". Of the eight major "trade areas", four dominate the world—Greater Europe, North America, U.S.S.R., and Asia—and the conclusion is reached that the future will confirm rather than reverse this position. It is thus regarded as a basic fact with respect purely to world air transport operations that the favoured position is at the hub of the hemisphere. While the disadvantages of America's peripheral position are partly offset by her gigantic industrial development and purchasing power, it is argued that more efficient operation and lower costs through greater volume will be needed to counter the handicap of longer average distance to world markets.

Attention is directed to the immensely strong position which could be held if only the countries of Greater Europe acted in unison. Despite the focal position of the British Isles, and the importance, above all others, of the difficult North Atlantic route, the suggestion is made that the limited land areas

available in Britain will be a handicap. Despite the war-time use of Goose Bay in Labrador, the author holds that the importance of trans-polar and high latitude routes has been much exaggerated.

That the main result of this frank American survey should be to affirm that "geography is still a controlling factor" and that Britain automatically becomes the centre of the future air-age world should give us in Britain food for serious thought. Forty years have passed since Sir Halford Mackinder wrote "Britain and the British Seas", yet technical progress and inventions have but underlined his concept of the importance of Britain's world position.

L. DUDLEY STAMP

BIOLOGY OF FLIGHT

The Biology of Flight

By Prof Frederick L Fitzpatrick and Karl A Stile. Pp vi+162 (London George Allen and Unwin Ltd., 1944) 8s 6d net.

THIS book attempts to cover a very wide field indeed, ranging from the flight of insects and birds, to aviation medicine, and the control of disease that may be spread by air travel. It gives very lucid if somewhat superficial description of these matters in a form which assumes no previous knowledge of the subject.

However, there is no need for simple treatment of a scientific subject to be inaccurate, unfortunately a number of inaccuracies suggest that the authors have little practical knowledge of, or very close contact with, some of the matters which they describe. For example, "from the practical standpoint . . . is considered unsafe for the average person to fly much above 20,000 ft because of the limits of present oxygen equipment". This is done almost every day by many thousands of pilots and air crews. Discussing Donati's altitude record of 47,358 ft (corrected), it is clear that the authors have overlooked the difference between corrected altitude and pressure altitude. Again, "a descent of 10,000 to 15,000 ft without ventilation of the middle ears will usually cause rupture of the ear drums". The factor causing rupture of the ear drums is the differential pressure to which they are subjected. This cannot be expressed in thousands of feet unless the absolute height is stated. Descent from 45,000 ft to 30,000 ft will not cause rupture.

The use of the word 'probably' in connexion with statements giving numerical data is out of place. The figures should be checked.

Some of the photographs are official British pictures from the Ministry of Information. The line illustrations are clear, but some do not seem to present an aspect of interest, for example, Fig 33. Fig 17, purporting to show the burning of a candle at various altitudes, bears little relation to the truth. It would have been better if the accurate photographic plate in Ruff and Strughold's "Atlas der Luftfahrtmedizin" could have been copied. Had the authors tried the simple experiment themselves with a candle, ventilated bell jar, and filter pump, they would have found a candle still burns dimly at the pressure corresponding to 40,000 ft.

There is a paucity of collected work on the biology of flight and a very definite place for an accurate simple treatise on the subject. It is a pity that the present book is marred by loose writing and misstatement.

B. H. C. MATTHEWS

CLIMATE AND HUMAN COMFORT*

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Bodily Reactions to Heat and Cold

THE temperature of the deep tissues of the human body is said to be 98.4°F in normal conditions, any large deviation from this value being uncomfortable, and in extreme cases fatal. It is generally stated that a rise of body temperature to 107°F is likely to be fatal, but there is no equally definite range of fall of temperature which can be regarded as fatal. Heat is continually being generated within the body, even during sleep, as the result of the chemical processes associated with breathing, digestion and physical effort, all these processes being grouped under the term metabolism. This heat is conducted to the skin, partly by the normal conducting power of the body tissues, partly by the blood-stream, and is dissipated from the skin to the environment. Heat cannot be conducted to the skin unless the temperature of the skin is lower than that of the deeper tissues of the body. Observations show that the skin temperature varies over different parts of the body, being lowest of all over the feet, and next lowest over the hands. From this we may appreciate that special care is needed in the design of boots and gloves for men exposed to conditions of extreme cold.

When the body is exposed to cold, the following reactions occur (a) the skin temperature falls, (b) there is an onset of shivering, an involuntary effort to increase the internal production of heat by muscular action, and (c) the adrenal and thyroid glands discharge fluids which accelerate the metabolic generation of heat.

When the body is exposed to heat, the sweat glands discharge sweat on to the surface of the skin, where it evaporates, and in so doing takes heat from the body. Heat is dissipated from the skin in three ways (a) by radiation exchange between the outer surface, partly clothing, partly uncovered skin which the body presents to the environment, (b) by convection of heat, which can be simply described as the carrying of heat from or to the surface of the body by the air coming into contact with it; and (c) by the evaporation of sweat.

There is in addition a small loss of heat in the respiratory passages and lungs, but in the discussion of the heat balance of the body we may neglect this item, though it may well be an important factor in determining comfort.

Indoors, the three items mentioned must balance the metabolic rate of generation of heat. Out of doors, in bright sunshine, the gain of heat from the unshine is effectively an addition to the metabolic rate. The convective loss or gain is proportional to the square root of the air speed, and the evaporation from unit wetted area of the skin, in given conditions of air temperature and humidity, must also depend on air speed in the same manner.

In low and moderate air temperatures, the evaporative loss of heat from the skin is practically independent of air temperature, and the only controllable modes of dissipation of body heat are those due to radiation and convection. These two factors are proportional to the difference between the temperatures of the surface of the body and of the air,

while the convective loss is also proportional to the square root of the air speed. Further, an increase in the amount of clothing worn has the same effect as putting an additional resistance into an electric circuit. It decreases the outward flow of heat and raises the skin temperature. The rate of loss of heat from the body can thus be decreased by wearing more clothing, by increasing the air temperature, or by decreasing the air movement, and it can be increased by reversing one or all of these possibilities.

In high temperatures, or during great physical exertion, the secretion of sweat and its evaporation is the main factor in the dissipation of heat from the skin. An examination of the measured rates of loss of heat by convection and evaporation shows the curious result that, even when the body appears to be completely wetted with sweat, the area of skin from which evaporation occurs is only about one third of the area from which heat is lost by convection. The rate of evaporation from unit wetted area is the greater the higher the wind speed, and the lower the humidity of the air. If, while the temperature is kept constant at such a high level that active sweating occurs, either the humidity is increased, or the air speed decreased, or both changes are made, the body responds by an increase of the wetted area of skin. The reverse of this statement is also true. No instrument can produce a parallel to this response, and so it is not to be expected that any instrument will enable us to measure in a simple manner the reaction of the human body to given atmospheric conditions.

We find that the human body can so react to a wide range of external conditions as to preserve the internal temperature at 98.4°F or near it. The skin tries to produce its own climate. This effort is most successful when one is just comfortably warm in bed, the temperature under the bedclothes being then $85^{\circ}\text{--}86^{\circ}\text{F}$.

Limits of Heat-stroke Conditions

A long series of measurements of the various factors involved in the heat balance of the body in controlled conditions of temperature, humidity and ventilation, made in the John B. Pierce Laboratory of Hygiene, Newhaven, Conn., by the Director (Dr C. E. A. Winslow) and Drs Herrington and Gagge, enable us to write down expressions for the magnitude of the heat losses from the body in any given conditions. The equation of heat balance of the body can be written in such a form as to give the highest relative humidity in which body temperature can remain constant, in given conditions of air temperature and ventilation. To allow for the possibility of very light ventilation, this is taken to be 17 ft per minute, and in what follows this rate of ventilation must be regarded as assumed, unless some other rate is specifically mentioned. It is also assumed that the temperature of the radiating solid surfaces in the environment is equal to the air temperature.

The details of the computation have been given elsewhere, and will not be repeated here. Fig 1 shows the results of five such computations. For men resting indoors, or in the shade, Curve AA gives the limit of tolerable conditions for a nude man, and Curve BB for a lightly clothed man. In conditions represented by a point to the left of the appropriate curve for nude or clothed men, the body temperature will not rise, while in conditions represented by any point to the right of the curve the body temperature will rise, and will continue to rise so long as exposure

* Discourse delivered at the Royal Institution on March 9

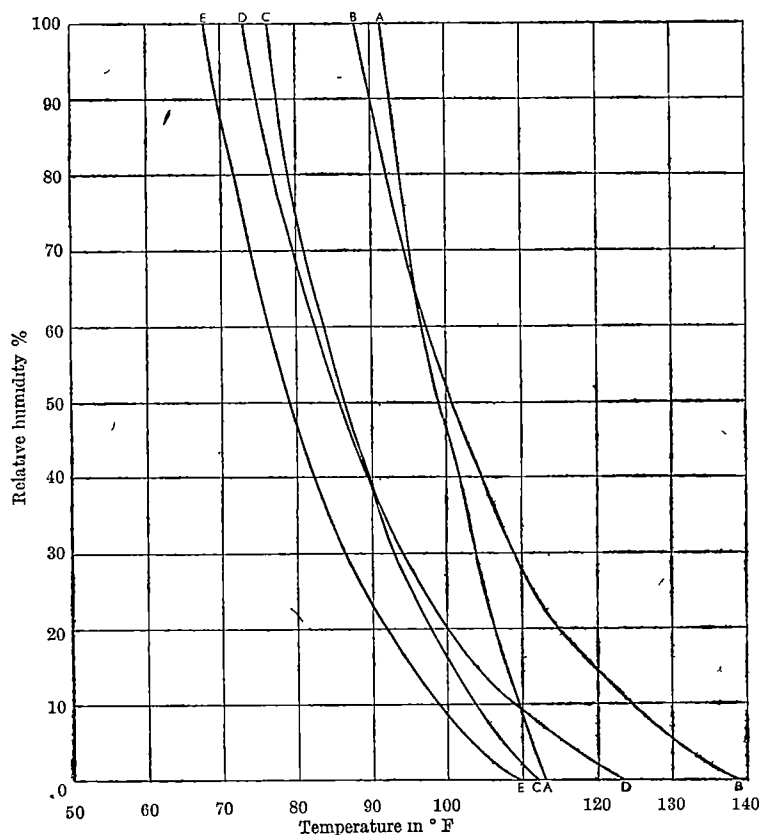


Fig 1* CURVES SHOWING THE LIMITS OF THE RANGE OF TOLERABLE CONDITIONS FOR VARYING DEGREES OF ACTIVITY, AA FOR NUDE SUBJECTS RESTING INDOORS, BB FOR CLOTHED SUBJECTS RESTING INDOORS, CC FOR CLOTHED SUBJECTS RESTING IN SUNSHINE, DD FOR CLOTHED SUBJECTS WALKING AT 4 M.P.H. (NO SUNSHINE), EE FOR CLOTHED SUBJECTS WALKING AT 4 M.P.H. IN BRIGHT SUNSHINE
* Figs 1, 2 and 3 are from Prof. Brunt's paper in *Endeavour* of July 1944

to these conditions is continued. With continued rise of body temperature, the blood-pressure falls, the pulse-rate increases, strong palpitation occurs, followed by a condition of stupor, ending in death by heat-stroke. It is seen in Fig 1 that the wearing of clothing affords considerable protection against heat, since, in completely dry air, the upper limit of tolerable temperature is about 138°F for a clothed man, and 113°F for a nude man.

Nothing that has been written above should be regarded as excluding the possibility of remaining for short periods in air at temperatures far beyond the limits prescribed by Curves AA and BB of Fig 1. In the *Philosophical Transactions of the Royal Society* of 1775 will be found several papers by Dr. Charles Blagden, later secretary of the Royal Society, in which are described experiments in rooms kept at very high temperatures. Blagden stayed in a room, in which the air temperature was maintained at $240^{\circ}\text{--}260^{\circ}\text{F}$, for a period of eight minutes, during the first seven minutes he experienced no discomfort, but the subsequent rapid increase of distress in breathing and of a feeling of anxiety caused him to leave the room after a total stay of eight minutes.

In Fig 1 Curve CC represents limiting conditions for a lightly clothed man, sitting in bright sunshine, Curve EE the limits for a clothed man walking at 4 m.p.h. in bright sunshine, and Curve DD the limits for a clothed man walking at 4 m.p.h. on a cloudy day.

A ready check on the limits set by Curve BB in saturated air is fortunately available. It has been pointed out by the late Dr. J. S. Haldane that in saturated air in coal mines a temperature of 88°F is about the highest temperature which can be tolerated, even by men not doing any work. This close agreement affords some confirmation of the reliability of the computations on which Fig 1 is based. Exposure to conditions in which body temperature rises by $1\text{--}1\frac{1}{2}^{\circ}\text{F}$ per hour produces no permanent injury, provided the exposure is not continuous over a long period. Thus with periodic withdrawal to cooler conditions, miners can work in conditions in which long-continued exposure would end in heat-stroke.

Acclimatization

It is generally acknowledged that within limits, it is possible for a man to accustom himself to living and working in temperatures above or below the normally accepted limits. Acclimatization to hot conditions consists largely in training the sweat glands to function efficiently, and perhaps in part in learning to avoid strenuous exertion. In temperate climates some degree of acclimatization is necessary at the beginning of each summer, since the sweat glands are inactive during the winter. When a very hot day comes at the beginning of summer, it is far more distressing than an equally hot day later in the summer.

Men who work in the very hot deep mines of South Africa are subjected to a regular process of acclimatization, first doing very light work in hot stopes, and then increasing slowly their rate of work. But even after acclimatization, when working in the hotter mine, coloured workers show a definite rise of internal temperature, sometimes amounting to 2°F or more when working in air, say, of temperature 85°F and relative humidity 98 per cent (wet bulb temperature 84.6°F), and ventilation 20 ft per minute. In saturated air there can be no loss of heat from the skin, either by convection or by evaporation, and sweat unless the skin temperature is higher than the air temperature. Further, if heat is to be transported to the skin from the deeper tissues, the internal temperature must be higher than the skin temperature. So, when a man works in saturated air at 95°F , his skin temperature must be higher than 95°F , and his internal temperature must be several degrees above the normal value, probably $101^{\circ}\text{--}102^{\circ}\text{F}$ at lowest.

Effect of Increased Ventilation

It is easy to compute limits of tolerable conditions with any selected rate of air motion, for nude subjects. The extension of the preceding work for clothed subjects is not at the moment possible. The conductivity of the clothing with air speed 17 ft/min has been evaluated from experimental data, but there is not available any series of observations from which the conductivity of clothing can be related to the air speed.

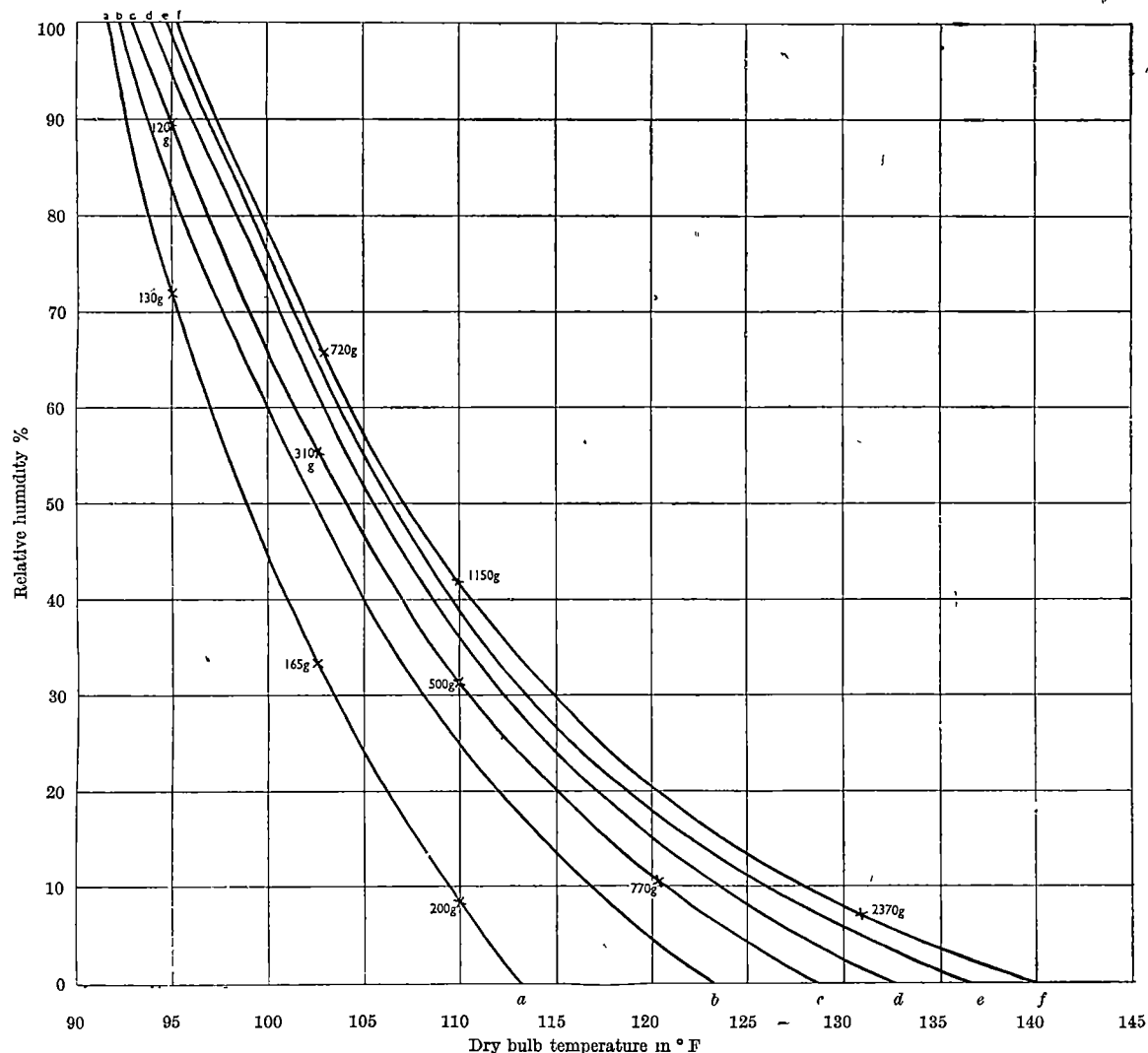


Fig. 2 THE EFFECT OF VENTILATION ON HEAT-STROKE CONDITIONS FOR NUDE SUBJECTS. THE CURVES GIVE LIMITING TOLERABLE CONDITIONS, *aa* FOR AIR MOVEMENT 0.085 METRE PER SECOND (17 FT PER MINUTE), *bb* FOR 0.25 METRE PER SECOND (50 FT PER MINUTE), *cc* FOR 0.5 METRE PER SECOND (100 FT PER MINUTE), *dd* FOR 1 METRE PER SECOND (200 FT PER MINUTE), *ee* FOR 2 METRES PER SECOND (400 FT PER MINUTE), *ff* FOR 5 METRES PER SECOND (1,000 FT PER MINUTE). FIGURES SUCH AS 200g MARKED ON THE CURVES INDICATE THE RATE OF LOSS OF WATER PER HOUR BY EVAPORATION FROM THE WHOLE BODY, SKIN AREA BEING ASSUMED TO BE 1.8 SQUARE METRES.

Fig. 2 reproduces a series of curves for six values of the air speed. It is seen that in a wind of a little more than 2 m.p.h. the limits are given by *dd*, and with relative humidity 60 per cent, the tolerable temperature is about 6° F higher than with air speed .7 ft/min., while in completely dry air the corresponding rise in tolerable temperature is nearly 20° F. The numbers shown on the curves indicate the rate of loss of water from the skin by evaporation of sweat, from the whole body of a man of average size (Skin area 1.8 sq metres, or 19.4 sq ft). For example, the 130 g indicated on Curve *aa* at 95° F, relative humidity 72 per cent, indicates that a man resting indoors in such conditions would lose water from the body by sweat at least at the rate of one pint in a little more than four hours. The 1,150 g shown at temperature 110° F, relative humidity 42 per cent, indicates that a man resting in the shade in these conditions with a wind of 1,000 ft/min. (11.1 m.p.h.) would lose water by sweating at the

rate of at least two pints per hour, while the figure of 2,370 g lower on the Curve *ff* indicates a loss of more than half a gallon per hour.

There are two aspects of these high rates of sweating which deserve further consideration. In the first place, sweat is not pure water, but contains, in addition to various organic compounds, common salt, and the salt lost by sweating must be replaced, or serious consequences to health will follow. Of these consequences miner's cramp is frequently cited as a typical example. In the second place, it should be noted that it is possible for dehydration of the body to cause sweating to stop. The consequences may be fatal. If, for example, a man is exposed to a wind of just over 11 m.p.h., at a temperature of 110° F and relative humidity 42 per cent, his body temperature can remain normal so long as he sweats at the rate of about two pints per hour. If he stops sweating, he will thus be exposed to conditions in which radiation and convection heat the body, while

there is no evaporative loss of heat from the skin. His body temperature will then rise, and he will die of heat-stroke. This appears to be the explanation of the deaths from the Smoom, the hot dry Poison Wind of Arabia, in which whole parties of men have perished together.

In very hot air of any assigned temperature and humidity, for any assigned rate of sweating there is a limiting air speed at which sweat is evaporated as rapidly as it is secreted. An increase of air speed beyond this limit, when a man is already sweating at his highest possible rate, will not increase the evaporating cooling, but will increase the convective heating, of the body. The body temperature will then rise, and will go on rising so long as the high air speed is maintained. This effect is to be observed in hot mines, where there may be a limit to the air speed in which efficient work is possible.

Classification of Climates

In Fig 3 are collected together such information as can be applied to classify climates. We have to allow for the possibility of very light winds. Lines *BB*, *CC* and *EE* are copied from Fig 1. To the right of *BB* conditions are intolerable for long-continued exposure. Between *BB* and *CC* a man cannot rest in bright sunshine without rise of body temperature or risk of heat-stroke, and cannot make any physical effort without such risk. This area in the diagram is marked 'very hot'. In conditions represented by the area between *CC* and *EE* a man cannot walk at 4 m.p.h. in bright sunshine without rise of body temperature, and the corresponding area in the diagram is marked 'warm'. At the other end of the temperature scale, it is generally agreed that at temperatures below 50° F it is cold, and at temperatures between 50° and 60° F it is cool. We are therefore left with an area bounded by the 60° F vertical line and the curve *EE*, which will contain the zone of possible pleasant conditions.

Within this range of conditions, by wearing suitable clothing, it is possible to do light work indoors or in the shade without sweating, and to rest without shivering. Experience in air-conditioning has confirmed this, and has shown that, with medium relative humidity, men can do light work indoors with the maximum degree of comfort in temperatures between 60° and 76° F. The optimum temperatures prescribed by heating and ventilating engineers are, in the United States, 76° F in summer, 72° in winter, in England, 66° in summer, 62°-64° in winter.

Very high relative humidity is oppressive at high and moderate temperatures, and raw at low temperatures. Very dry air is keen at low temperatures, while at moderate and high temperatures it is at first stimulating, but ends by producing irritation, headaches, and a marked tendency to becoming quarrelsome. The Fohn wind, a warm dry wind which blows down the sides of many mountain ranges, has long been notorious for producing these effects of irritability and quarrelsomeness, and dwellers in some desert regions manifest an undesirable permanence of irritability.

Fig 3 is based on an assumption which was stated earlier, but requires emphasizing, that the temperature of solid surfaces is the same as the air temperature. There are conditions in which this assumption is not justified, particularly in hot sunny climates, in which the walls and roofs of houses and any solid objects exposed to the sunshine attain a

very high temperature. When this occurs, the radiation from the solid surfaces in the environment will be much greater than would be computed on the basis that they are at air temperature. Contact with very hot solid objects leads to a degree of discomfort which can only be described as little short of misery. Most white men find that a temperature of 105° F is near the limit of tolerability in these conditions.

It follows that there are two types of hot climates (a) the oppressive, warm, damp type of climate, usually with overcast skies and little fall of temperature at night, and (b) the hot dry sunny climate, the undesirable nature of which has been stressed in the last paragraph. Comfort is determined by the temperature, humidity and rate of motion of the air. If air-conditioning were possible, we should treat (a) by drying, and (b) by cooling, the air indoors. In the absence of air-conditioning, all that can be done in case (a) is to increase the ventilation, or to sit in the greatest draught. In case (b) increase of ventilation is not effective, and it is better to close all doors and windows of the house in the early morning while the air is still cool, and to ventilate indoors by electric fan where possible. The oppressive warm, damp climate calls for an open type of house permitting free air movement, while the hot, dry, sunny climate calls for a house having double walls and roof, with a wide air space, and capable of being closed up fairly tightly against the intrusion of the hot outer air during the day.

In India, a simple expedient is frequently adopted for cooling the air in houses, water-soaked curtains or tatties being hung over doorways through which air enters the rooms. The evaporation of water from the tatties into the air cools the air, by taking from it the latent heat required for evaporation. Now in such a process of evaporation, while the dry-bulb temperature falls, the wet-bulb temperature of the air remains constant. But it would be found that along any of the curves of Figs 1 and 3, the wet-bulb temperature falls as the temperature rises. In other words, a given wet-bulb temperature becomes more uncomfortable, for any degree of physical effort, in any degree of ventilation, as the dry-bulb temperature increases.

The Ideal Climate

Can we now determine the ideal climate? To this question a definite answer can be given provided we have a clear statement of the *idea* underlying the search for the *ideal*, and we must avoid the common error of regarding the climate in which it is pleasant to spend a summer holiday as the ideal climate in which to live permanently, and to do one's work. Before we can determine the ideal climate we must, in fact, know for what degree of activity the climate must be ideal. Clearly the ideal will not be found either in the very cold polar regions or the very hot tropical regions. In a paper published some two years ago, I endeavoured to solve the first stage of the problem by postulating that it should be possible for a lightly clothed man to walk at four miles per hour in the sunshine without sweating, and to sit in the sunshine, or stand or sit in the shade or indoors doing light work, without shivering. With relative humidity of about 60 per cent, the temperature to fit this prescription will be between 66° and 68° F, and the optimum is thus 67° F. For the nude man the optimum temperature will be about 4° higher, say 70°-71° F.

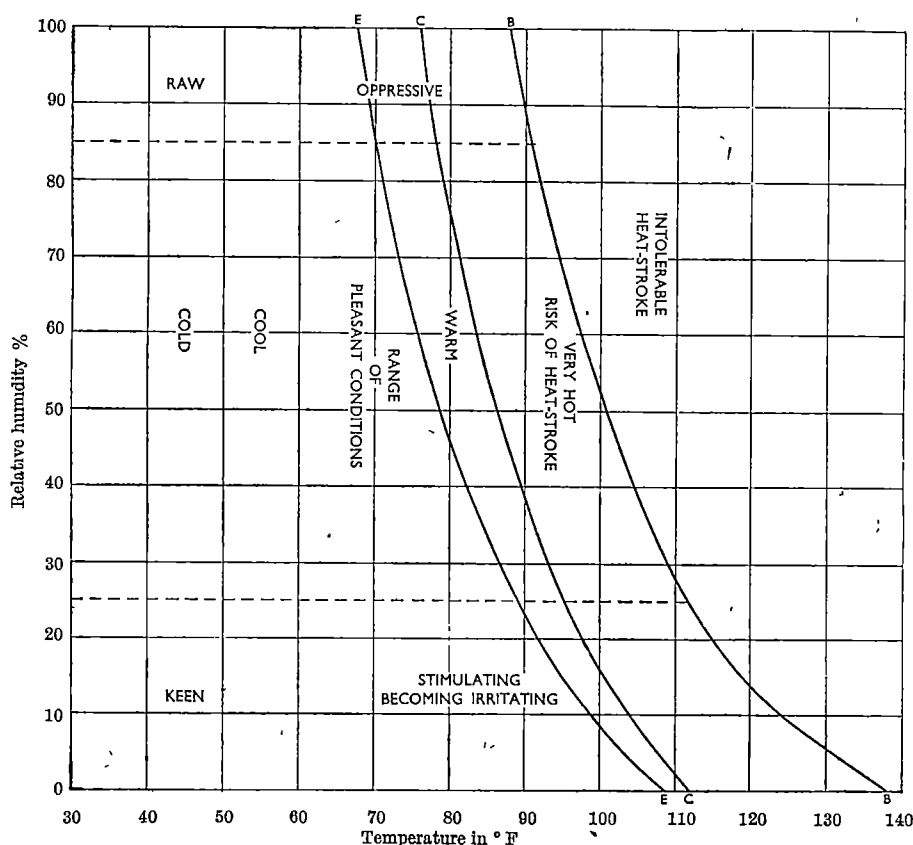


Fig 3 A TENTATIVE CLASSIFICATION OF CLIMATES

Major S F Markham, in his book "Climate and the Energy of Nations", has directed attention to the fact that, on a world map of annual mean temperatures, the 70° isotherm passes through, or close to, all the centres of early civilizations in Egypt, Palestine, Assyria, Sumeria and Persia, and not far north of Mohenjodaro, the centre of the early civilization in the valley of the Indus. Thus the early civilizations arose in regions where the mean temperature of the year is now, and probably was then, 70° F or very near it, and as they were founded by men who wore so little clothing that we may regard them as nude, we may take this as a confirmation of the estimate given above of the ideal temperature for the nude man.

An annual mean temperature of 70° F would mean summer temperature well above the limit, and a winter temperature well below it, so that the summer months would be too hot, and the winter months too cool, for comfort. With the development of methods of indoor heating in winter, the optimum conditions would shift to climates where the summer was less extreme, but the winter cold not such as to make indoor heating impossible, as exemplified in ancient Greece, and still more notably in the Roman Empire. With the fall of the Roman Empire, indoor heating became far less common, and almost died out, and the next major civilization, the Muslim, arose again in the region of the 70° F isotherm. Later, in western Europe, as indoor heating developed, and houses once again became weather-proof, civilization began to make rapid strides.

We can now go a stage further, and state that for healthy and active life the climate must be such

that the mean temperature of the hottest month shall not exceed 70° F, or at most 75° F, while the coldest month of the year shall not be so cold that it becomes difficult or expensive to maintain a comfortable temperature indoors. Markham (*loc cit*) states that when a white man migrates to a country where the mean temperature of the hottest month of the year exceeds 75° F he finds that, whereas he and his children may be able to tolerate the changed conditions, his grandchildren will show a marked loss of energy and of mental and physical efficiency. Markham suggests that the 'poor white' problem which has arisen in many hot countries is a result of migration to unsuitable climatic conditions. It is unlikely that any simple hard-and-fast rule can afford a solution of the problem of desirable climates. Some allowance must be made for the effects of low relative humidity and of high wind speed, in modifying the disabilities of hot climates.

An examination of world maps of mean temperatures for each month of the year shows that only a very small fraction of the land areas satisfies the condition that the hottest month of the year has a mean temperature not above 75° F, while the coldest month of the year has a mean temperature not below freezing point. The largest single area satisfying these conditions is that part of western Europe which includes the British Isles, France, northern Spain, Switzerland, Germany, the Netherlands, Denmark, and a strip along the south-western shores of Scandinavia. Within this area, there is a higher level of health and prosperity than in the neighbouring regions.

Markham quotes a considerable volume of statistics

relating to health and prosperity for different countries, showing the lowest death-rate and the lowest infantile mortality for the years 1926-35 to be those of New Zealand, the country which I have always regarded as having the best climate of all countries in the world. Over most of New Zealand the mean temperature of the hottest month lies between 62° and 70° F, and that of the coldest month between 45° and 52° F. We might compare these figures with the corresponding figures for the British Isles, where the July mean temperature lies between 58° and 62° F, while the mean temperatures of the coldest month of the year lie between 39° and 44° F. In the British Isles, temperature readings above 90° F are infrequent, and values exceeding 95° F are decidedly rare, being generally confined to the inland regions of the southern half of England. In the British Isles the highest temperature recorded during a month may exceed the mean for that month by about 20° F in winter, and by about 30° F in summer, while the lowest temperature recorded may fall below the mean of the month by about 30° F in winter, and by about 20° F in summer.

Development of the Weather-proof House in England

The weather-proof house required glass for the windows, bricks for parts at least of the structure, and the fireplace and chimney as we know it. The history of the development of these three features in England is by no means clear. Houses were glazed in the Roman Empire, but the making of glass disappeared from Britain with the Romans. The Venerable Bede described how, in 675, Benedict, when building a church at the mouth of the Wear, had to go to France to find and bring back glass workers to glaze the windows of his church. Bede further states that these glaziers not only glazed the church windows, but also taught the English how to make glass. The knowledge they imparted was not lasting, for in 758 we find the Abbot of Jarrow appealing to the Bishop of Mainz to send him a craftsman in glass. The earliest evidence we find of glass-making in England refers to 1230, in which year a deed granted certain lands at Chiddingfold in Surrey to one Lawrence, "vitrarius". Chiddingfold was apparently the earliest centre of glass-making, but English glass was poor in quality until the sixteenth century. Even then glass windows were so rare and valuable that they were often bequeathed, like jewels, apart from the house. The decision by the Court of Common Pleas in 1599, that glass windows should not be removed from a house, reveals the prevailing state of things with regard to windows.

Aubrey, an antiquarian writer of the seventeenth century, said that glass windows were rare except in churches and gentlemen's houses until the time of Henry VIII, and added that to his own remembrance, copyholders and poor people in Herefordshire, Monmouthshire and Shropshire had none before the Civil War. Aubrey also wrote that before the Reformation, ordinary men's houses "had no chimneys, but flues like *louvre* holes. Some of 'em were in being when I was a boy".

So far as definite records are available, bricks were first made in England (at Hull) in 1303, and only became reasonably good and cheap a century later. One of the earliest examples of brickbuilding in England, with English bricks, is the north and east part of Queens' College, Cambridge, built in 1448.

There are still to be seen in England a few houses

with fireplaces and chimneys as we know them dating back to the middle of the twelfth century, as for example the Norman House at Christchurch, Hants (the ruins of which are in the gardens of the King's Head Hotel), built between 1125 and 1150, and a house at Boothby Pagnell, Lincoln, built about 1150. But chimneys as we know them only became common about the time of Henry VIII.

We can thus say that by the time of Henry VIII the weather-proof house had become possible in England, but was still too expensive except for the wealthy, and that it was late in the sixteenth century before it became widespread throughout the country. The development on the Continent was roughly parallel with that in England. Once weather-proof houses had become general, England had a great advantage in its cheap supply of coal for indoor heating, and it may not be a fortuitous coincidence that the glories of Elizabethan England came soon after the advent of the weather-proof house.

MICROBIOLOGY

ITS BASIC CONCEPT AND ITS FUTURE

By DR A C THAYSEN

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IT will probably be conceded that the terms 'microbiology' and 'biochemistry' can be roughly translated into English as the knowledge of invisible life and as the chemistry of the living cell respectively. As such, these definitions aptly circumscribe the fields of study embraced by the two branches of science. Yet, all too often, the term microbiology is referred to as synonymous with that of biochemistry, as if these two branches of science dealt with identically the same problems, required the same training, and would use the same approach to the solution of their problems. This, however, is not necessarily the case and has no foundation in the basic concept of microbiology.

If one searches for this basic concept, one must eventually be led back to the living cell itself as it exists in its natural habitats. For only by a study of the changes which the cell performs under such conditions does it appear possible to obtain a correct insight into its functions, and only by an evaluation of these functions under controlled growth conditions can a measure be obtained of the future possibilities of the science of microbiology. This is undoubtedly the lesson to be learned from the polemic between Pasteur and Liebig in their writings on the function of yeast in fermentations, and it is the axiom insisted upon by Koch, when he demanded that, before a disease can be ascribed to the action of an organism it is essential to grow the suspected type under artificial conditions free from all others and to produce with the cultured specimen the identical symptoms in healthy animals which had been observed to occur in diseased forms under natural conditions.

A primary function of microbiology then appears to be the study of micro-organisms in their natural habitats and to endeavour to isolate them from these for cultivation under artificial conditions with the view of reproducing natural changes or any other changes of which they may be found capable.

The knowledge which has accumulated^o since Leeuwenhoek first observed micro-organisms in droplets of water has shown, not only that the invisible population of the earth is as abundant as is its macroscopic counterpart, but also that it is met with in places and under conditions which would be utterly inadequate to sustain the life of higher organized plants or animals. This presupposes a flexibility in the make-up of the free-living microscopic cell which far exceeds that of any higher organized living being and gives an insight into the diversity of the problems with which microbiology may be called upon to deal. On the other hand, a study of the natural habitats of micro-organisms should make it possible to circumscribe the limitations of this branch of science.

For example, the microscope reveals that, where water is present, even in the form of a humid atmosphere, free-living microscopic cells can be met with almost anywhere. On the surface of inert objects, in the arctic ice, in the sea, in the soil, in the hot springs of volcanic localities, in subterranean oil wells, on the surface of living plants and animals, in the intestinal tracts of animals and throughout the interior and exterior of dead and dying animal and vegetable tissues, actively growing microscopic cells are present. In such varying habitats, then, must they find conditions which make it possible for them to survive and to propagate their kind.

On the other hand, where water is absent it may safely be predicted that no microscopic life can persist, and it may positively be asserted, for example, that the so-called 'curse' of the tomb of Tutankhamen could not possibly be ascribed to microbiological life, as was done in some quarters when this tomb was opened and found devoid of moisture.

There are, of course, other limitations, such as temperature and reaction, but the range here is often extraordinarily wide, much wider than would be feasible among higher cell organizations.

A particularly interesting form of limitation of types rather than of numbers is met with in the soil and among the microflora and microfauna of the intestinal tract of most animals, where a few types have established themselves irrespectively of the feeding habits of the animal. Though a much wider range of types must originally enter the intestine they appear unable to survive in competition with the established forms.

The mechanism by which such specialization is brought about can only be ascertained by a study of the habits of the living cell itself. It is conceivable that the rate of growth of the established types may be faster than that of the accidentally entering cells, either because the conditions prevailing favour the former, or that the normal types during their growth produce substances which are harmful to all but the established types. Whatever the explanation, the example given illustrates the influence which the natural habitat may exercise on the organisms living in it and indicates the importance which must be attached to its study.

An extensive exploration of some of these habitats began during the second half of the nineteenth century. Because of the utilitarian aspect of this study it resulted not only in added knowledge and in a widening of the field of microbiology, but unfortunately also in a subdivision of the science into at least four different and more or less water-tight compartments: medical, or pathological bacteriology, dairy bacteriology, soil bacteriology, and the mycology of the fermentation industries. Though

this specialization may have been unavoidable at the time, it did much to obscure the potentialities of microbiology. It is undoubtedly responsible for the neglect of many fields of exploration, such as the microflora of oil wells and oil storage tanks, of the rotting of textiles and of the corrosion of metallic structures in soils and water. How important an extension of the exploration of natural habitats of micro-organisms can be, can be seen from the modern developments in sewage purification and in the retting of textile fibres.

Turning to the free-living cell itself and to the bearing which its study must exercise on the progress of microbiology, it appears appropriate to illustrate this by a few examples. The first which comes to one's mind is the revolution which was caused in the brewing industry by the introduction of pure cultures in the brewing of lager beer. There are many others which carry equal weight, such as the prophylactic treatment of infectious diseases with pure cultures of certain pathogenic organisms, the preparation of 'starters' for cream used in butter-making, the inoculation of deficient soils with cultures of specific strains of nitrogen-fixing bacteria and, to take a more recent example, the use of micro-organisms in the assay of vitamins.

If it be conceded, then, that a knowledge of both the living cell and of its habitat is essential for the successful expansion of microbiology, it is relevant to ask how such knowledge should be circumscribed. Obviously it should be as comprehensive as possible and should embrace all relevant information on the morphology, the biology, including cytology and physiology, and the chemistry of the cells, the latter, both as regards their composition and their functions. An exclusive study of one or two of these aspects would fail to give a balanced picture of an organism and would in many cases lead to an erroneous estimate of its potentialities. For example, in the case of the preparation of gluconic acid by certain fungi, the conversion of the sugar used is governed by the biochemical properties of the organism. But it is influenced also by its morphology, for it has been shown that the action of the fungus used on the sugar which it converts to gluconic acid can be greatly increased by a change in the morphology from matted hyphae to smaller cell aggregates which can be more uniformly aerated than the mats of hyphae.

Again, in the production of baker's yeast, an industry which is based on the ability of certain yeasts to build up their cell substance from carbohydrates and inorganic nitrogen, the rate of growth of the cells is markedly influenced by the number of cells present in their habitat at any given time. Here a study of the growth-rate of the individual cell will indicate the conditions required to secure full advantage of the biochemical process of the organism.

Finally, a case may be cited in which the exploration of the biochemical activities of an organism supplied the clue to the connexion between its growth and the spoilage of fish living in the proximity of its natural habitat. It had been observed that trout and salmon entering certain rivers became useless as a food because their flesh became contaminated with a pungent earthy taint. The origin of this taint remained obscure until an examination of the river beds revealed extensive areas covered with the growth of a micro-organism which produced a volatile organic nitrogenous substance. This substance, when dissolved in high dilution in water in

which fish were living, imparted to their flesh the same earthy taint with which the spoiled fish had been tainted

Reverting to the significance of biology in microbiological research, it is relevant to point out that without its aid it would be impossible to describe an organism and to compare or identify it with known types for eventual classification and conservation. Neglect in this respect has been responsible in the past for much confusion, and many types already studied have been lost in the course of time with little hope of recovery, because their original description was wholly inadequate for them to be re-identified. Within the last two decades a serious effort has been made to remedy this state of affairs by the acceptance of a standard code of identification and by opening in various countries specialized collections of type cultures in which recognized types of micro-organisms are maintained and into which new types can be incorporated as they become known, each provided with a comprehensive description, covering its general biological characters, its relationship to other types, as well as any special pathogenic, chemical or other properties which it may possess.

Turning to the place of chemistry in microbiology, it is probably correct to claim that its functions should be twofold. It should explore the relevant changes in a habitat which result from the metabolism of micro-organisms, and it should investigate the chemical composition of the organism itself so that information may be obtained on its food requirements. Further, the intermediary products which result from its activity should be explored so that the steps can be ascertained by which the final metabolic products are arrived at.

In the course of time chemistry, as applied to micro-organisms, has branched off into a third direction which cannot be regarded as strictly relevant to its main function. This side-line originated in the observation that the metabolic processes of micro-organisms are fundamentally similar to those of higher organized forms of life. The free-living microscopic cell, therefore, with its much contracted life-cycle, is often chosen for the study of metabolic changes, which might not be as conveniently explored on tissues removed from higher animals or plants.

Within its more legitimate sphere, the chemistry of micro-organisms covers a wide field of unexplored ground, in spite of the not inconsiderable amount of information which has been acquired already. Such knowledge makes it possible, for example, to predict with some measure of assurance the nature of some of the chemical compounds which can be produced by micro-organisms and the stages through which the substances utilized by the free-living microscopic cell are broken down into final metabolic products. This is particularly so in the case of the carbohydrate metabolism of micro-organisms. Much less is known about the changes through which nitrogen passes under their influence, and still less of those in which sulphur, phosphorus, silicon and other elements may be involved.

As for the carbohydrates, it may be said that, whether they be polysaccharides or monoses, hexoses or pentoses their breakdown by micro-organisms gives rise to the same ultimate products—carbon dioxide and water. Some organisms fail to utilize carbohydrates to this extent and more complex end-products will result, notably organic acids, alcohols,

ketones and esters. But even in such cases, and in spite of the seemingly endless possibilities, the number and the nature of the end-products will be restricted to comparatively few groups. This is due to the standardized type of enzyme reaction employed by micro-organisms in metabolizing carbohydrates, even where the organisms belong to the most varied biological groupings.

It is for this reason that the application of micro-organisms in the preparation of organic compounds from carbohydrates must remain a limited field of application, a field which in the course of time, and for economic reasons, may become even further restricted than it is to-day. Where fermentation processes have already been introduced, for example, in alcohol manufacture and in the production of citric, lactic and acetic acids, they have in most cases maintained their economic predominance. That they will do so in future is already problematic, at any rate in the case of lactic and acetic acids, other than vinegar. For these acids can now be produced more cheaply by chemical methods than by fermentation. That vinegar is still made commercially with the aid of micro-organisms illustrates the advantage possessed by fermentative processes in such industries as brewing and wine production, which are based on the conversion of carbohydrates into products in which subtle and often undefinable metabolic substances constitute an essential part of the final product.

It has already been mentioned that the biochemical aspect of the nitrogen metabolism of micro-organisms is far less explored than that of carbon. Nevertheless, micro-organisms have been, and are being, used on the largest scale in processes which are based on the nitrogen metabolisms of such organisms. The fixation of atmospheric nitrogen in the soil by addition of pure cultures of certain bacteria is a case in point, removal of undesirable tissues from hides in leather manufacture, sewage disposal, casein digestion in cheese-making, and protein synthesis from inorganic nitrogen compounds are others.

A very special interest is attached to the chemical exploration of bacteriostatic and bacteriolytic substances produced by micro-organisms, substances into the composition of which nitrogen enters. A purely biological approach to this subject, though an essential preliminary, would not suffice for full advantage to be gained from the existence of these substances. Their production by micro-organisms at any given time may often be totally inadequate for large requirements, and they will, moreover, often be difficult to isolate from the substrates in which they have been produced biologically. The final goal here would appear to be their chemical identification and synthesis by the organic chemist.

Recent work on the sulphur metabolism of micro-organisms has brought to light several interesting observations which indicate that this field also may be of interest not only to the biologist but also to the chemist, the farmer and the engineer. For it has by now been established that certain micro-organisms, through their sulphur metabolism, play a significant part in the corrosion of metallic structures which are exposed in soils or water. Others influence soil fertility through their sulphur metabolism.

The fields of the phosphorus and silicon metabolism of micro-organisms remain almost unexplored. If experience gained in other fields may be taken as a guide, an exploration here could most profitably be approached by a study of those micro-organisms

which occur in places where phosphorus or silicon undergo 'spontaneous' changes

This brings the discussion back from a contemplation of the functions of chemistry in microbiology to the question of the significance of the free-living cell in its natural habitat, a question which has already been referred to as fundamental. It seems appropriate at this juncture to substantiate its contention by a further example

Where micro-organisms develop in their natural habitats they do so at the expense of substances which can serve their energy requirements. Such substances may range from highly complex organic compounds to simple elements. The result of the action of micro-organisms on them will inevitably be a change in their chemical composition, a change which, if undesirable from a human point of view, will be characterized as destructive

The destructive activities of micro-organisms are so manifold to enumerate, ranging as they do from the taking of human life to the elimination of dead vegetation, from the spoilage of milk and all other foods to the mildewing of fabrics, from the consumption of gas stored in gasometers to the destruction of natural rubber, or the breakdown of liquid fuels, or the corrosion of metallic structures. The study of all such destructive activities and a clarification of their significance must always constitute a major function of microbiological research, worthy of a degree of attention at least equal to that devoted to the adoption of micro-organisms as catalysts in the production of organic substances.

What bearing, it may finally be asked, has all this on the planning of future microbiological research?

It implies that the biological aspect should be safeguarded in greater measure than has been done in the past, and that a more general approach to the subject should be encouraged, not, be it understood, at the expense of specialized investigations, but in addition to and in amplification of them.

There will be needed in future a more comprehensive survey of the natural habitats of the microscopic world than has hitherto been undertaken. There is needed to-day for a much more thorough exploration of the destructive activities of micro-organisms than has so far been conducted. There is need for a better understanding of the symbiotic and antagonistic activities of micro-organisms, and of the adaptive properties of the microscopic world in its natural habitats. There is need for more work connected with the classification and preservation of type cultures, and for a fresh approach to an understanding of the biological and biochemical principles underlying established microbiological processes.

Improvements in such processes could not fail to result from such work. Finally, there is need for the training of workers in general microbiological principles. Planning of microbiological research on the above lines is unlikely to be effectively undertaken in laboratories designed for specialized purposes such as pathology, dairying, soil investigations or biochemistry.

A homestead for general microbiological research is needed suitable for carrying out also the training of workers on more general lines than has been customary in the past. By whom such an establishment should be conducted, by universities or under Government auspices, may be a matter for discussion. Of its usefulness there can be but one opinion.

OILFIELDS IN GREAT BRITAIN*

By DR G. M. LEES

Anglo-Iranian Oil Co., Ltd

IN *Nature* of March 31, 1934, an article on "Petroleum in Great Britain" gave the following conclusion on the prospects

"Oil pools of commercial magnitude (*pace* natural gas, shale oil and allied indications and potentialities) cannot reasonably be anticipated in any known area in Great Britain. Many years of official geological survey—a centenary in 1935 in point of fact—together with much independent work, leave few spots unknown, if not in detail, at least in sufficient outline to preclude even faint hope"

On December 6, 1944, G. M. Lees and A. H. Taitt read a paper to the Geological Society of London on "The Geological Results of the Search for Oilfields in Great Britain" and the president of the Society, Prof. W. G. Fearnside, on opening the discussion, said that "Never before had so much exact and new information about the underground geology of Britain been presented to the Society. The D'Arcy Exploration Company's [the exploration subsidiary of the Anglo-Iranian Oil Co.] delivery of some 300,000 tons of native oil had been a notable contribution to the war effort, but the by-product of knowledge gained of Carboniferous rocks, under and about the edges of the coalfields, was not less vital in the interests of the nation"

The pessimistic, though confident, opinion of 1934 was presumably written without a full appreciation of the capacity of the modern technique of geophysics and of rapid exploration drilling to probe the structural and stratigraphical secrets below the unconformable cover of Permian and Mesozoic strata. This blanket completely obscures the older rocks throughout extensive areas in the Eastern Midlands, East Anglia and south-central England, and such borings as had penetrated below the unconformity were too few and too scattered to allow any satisfying deductions to be drawn from their results. These areas were, therefore, virtually *terra incognita* at depths below a few thousand feet, or less, from surface.

The exploration programme of the D'Arcy Exploration Company has extended over a number of separate and unrelated geological prospects—the Mesozoic in southern England, the Carboniferous in the western and eastern Midlands, the Permian in North Yorkshire and the 'Calcareous Sandstone Series' in Scotland. During the course of the past ten years, intensive geological and geophysical work and the drilling of fifty-two deep and forty-three shallow exploration borings by the Company have yielded an immense amount of new information. They have proved five oilfields and two areas of natural gas, and these fields are now producing from 243 wells. The total production up to the end of 1944 was 337,000 tons. The crude oil is of good quality, with good light and lubricating oil fractions. The specific gravity ranges from 0.83 to 0.89.

The oilfields are situated about eight miles north-west of Newark at Eakring, Duke's Wood, Caunton and Kelham Hills, and there is one isolated small field at Formby, between Liverpool and Southport. The Nottinghamshire oilfields produce from depths of 1,900–2,500 ft from sandstones in the Millstone Grit Series and, to a lesser extent, from sandstones

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in the basal part of the Coal Measures. The oil is concentrated in the crestal parts of minor anticlines forming part of a major anticlinal area which extends from the Trent at Rolleston to the vicinity of Ollerton. The Formby oilfield is a small accumulation in Keuper Waterstones sealed upwards by Glacial clay, and in this case the oil is produced from a depth of 100–120 ft. The structure is a faulted monocline, but it is thought probable that the oil has migrated upwards from a lower source, perhaps in the Carboniferous. Two deep borings have been made to explore the lower possibilities, but so far without result.

The gas-fields are at Aislaby in Eskdale, North Yorkshire, and at Cousland near Dalkeith, Scotland. In the former case the reservoir rock is a Permian limestone, and in the latter it is the sandstones of the Oil Shale Group of the Calciferous Sandstone Series. Short tests have indicated that the gas may be present in sufficient quantity to justify commercial exploitation.

The discovery of the Nottinghamshire oilfields resulted from geophysical work carried out, for the most part, by the staff of the Anglo-Iranian Oil Company. Seismic refraction arc surveys have proved to be the most successful method, whereas the reflexion method has given disappointing results. Gravity and magnetometer methods have also been used. These geophysical surveys have revealed the presence of a number of structural highs in extensive areas in eastern Nottinghamshire and in Lincolnshire, and a number of these have already been tested by drilling, although the ratio of success to failure has been low, the search continues.

An immense amount of new geological information on the stratigraphy and structure of the Carboniferous rocks below the Permian unconformity has been revealed by these borings. Coal seams of significant thickness have been penetrated by borings at Spital, Dunston and Stixwold, north, south and south-east respectively of Lincoln City. The coal seams lie at about 4,000 ft depth, and although for this reason they are not likely to be mined in the near future, they represent a substantial addition to the known British reserves of coal. It is possible that coal seams at shallower depth may be present underground in the surroundings of the Wash or even in north Norfolk, the former possibility was already envisaged by Prof. Kendall many years ago. On the debit side of the coal account, the area north of Newark, both east and west of the River Trent, has been proved to lack coal seams of important thickness, while to the south of Newark there is a considerable area in which there is an exceptional development of volcanic rocks within the Coal Measures, at the expense of workable seams. Farther south, however, there is an improvement, as a boring at Widmerpool, eight miles south east of Nottingham, has proved two good seams.

Another important by-product of the search for oil has been the discovery of potash salts of Permian age in Eskdale, North Yorkshire. Both sylvite and polyhalite are present, and this result shows that the potash deposits of the Zechstein Sea, which have such economic importance in north-west Germany, extend also into north-eastern England. The potash beds in Eskdale are at a depth of 3,650–4,775 ft and, while this may exceed easy mining depth, there is a possibility that the deposits may extend farther north towards the Tees valley and rise to a lesser depth.

Inevitably, after several decades of rural spoliation by uncontrolled industry, a certain apprehension has

been felt lest the development of oilfields might be at the expense of the amenities of the countryside in Britain but it need not and has not been so. Every care has been taken to cause as little disturbance as possible, after a well has been drilled, the derrick removed and only a small pumping jack marks the position of the boring. Electric power is used for pumping, and the motors are both small and silent. Buried pipelines carry the oil from the fields to railway siding whence it is transported in tank cars to a refinery.

OBITUARIES

Engineer Vice-Admiral Sir George Goodwin, K.C.

ENGINEER VICE-ADMIRAL SIR GEORGE GOODWIN GOODWIN, who died at Havant on April 2, was the sixth to hold the important position of engineer-in-chief of the Fleet—an office created in 1847. The first two holders, Thomas Lloyd and Sir Jam Wright, were civilians, but after the latter retired in 1887, the holders have all been naval engine officers. Richard Sennett, an inspector of machinery following Wright and he in turn being succeeded by Engineer Vice-Admirals Sir John Durston, Sir Henry Oram, F.R.S., and Sir George Goodwin. These four distinguished officers were all products of the admirable system of training inaugurated by the Admiralty in the dockyards and at the Royal Naval College, Greenwich.

Goodwin, who was born in 1862, became an engineer student at Portsmouth and received part of his education in the Dockyard School. Whilst a boy, he attained the highest position in the Cambridge Local Examinations and thereby became available for a scholarship at the University of Cambridge. He chose to continue his naval career, however, passed through Greenwich with distinction and except for about four years afloat, was afterwards employed either at Chatham Dockyard or at the Admiralty. He rose through the old ranks of assistant engineer, engineer and chief engineer, to the new ranks of engineer commander, engineer captain and engineer rear-admiral before, in 1917, on his succeeding Oram, reaching the highest rank at present open to a naval engineer officer.

In Goodwin's early days, there were many ships with low-pressure boilers and simple-expansion engines. He saw these types of machinery give way to compound- and triple-expansion engines, steam turbines, water-tube boilers and other important innovations. Known to a large number of officers afloat and ashore, he helped to bridge the gulf which existed between the engineering staff at the Admiralty and engineer officers in the Fleet, and on his retirement was entertained at dinner in the Grand Hotel, London—a unique occasion.

Among Goodwin's honours was that of the honorary degree of LL.D. conferred upon him when he attended the James Watt centenary celebration at Birmingham in 1919, as the Admiralty representative. He was the first naval engineer to be recognized by any university in Britain.

After his retirement from the naval service, Sir George Goodwin threw himself heart and soul into the work of various technical institutions, and in 1925 joined the old-established shipbuilding and engineering firm of J. Samuel White and Co., Ltd. of East Cowes, of which he became chairman.

Dr. G. L. Taylor

THE untimely death of George Lees Taylor at the age of forty-eight has robbed medicine and genetics of an able and industrious worker who had made notable contributions in this field. Born in 1897 at Ashton-under-Lyne, the son of Albert Taylor, he graduated in medicine at the University of Manchester

in 1920 after a distinguished undergraduate career. After two years of resident hospital appointments, Taylor spent seven years in general practice, but in 1929, when the chance occurred to become John Lucas Walker Student with Prof H. R. Dean at Cambridge, Taylor decided to abandon practice and devote himself to teaching and research. During the next six years Taylor's work was chiefly serological, and he published a series of ten papers on reciprocal reactions which established his reputation for painstaking and consistently sound work. During this time he was awarded the M.D. with commendation (Manchester) and the Ph.D. (Cambridge).

When, in 1935, the Rockefeller Foundation enabled the Galton Laboratory, University College, London,

to establish a special department for the study of blood groups in relation to human genetics, Taylor was ripe to take charge of this work, and he threw himself into it with characteristic zeal and determination.

Detailed study of the blood groups and their genetics had received but little attention in Great Britain, and Taylor had first to establish reliable methods and criteria for the A, B, O groups, the M and N factors and such other blood group factors had been described elsewhere. To widen his experience he studied for a time in Denmark with I. J. V. Jørgensen, and during 1935-39 he busied himself with the distribution of blood groups in Great Britain and with investigations upon rare human anomalies such as Huntington's chorea and acholuric jaundice.

At the outbreak of war Taylor at once took charge of the Galton Serum Unit established in the Department of Pathology, Cambridge, to provide adequate

supplies of reliable grouping serum for war purposes, and it is scarcely too much to say that the swift development of reliable Blood Transfusion Services throughout Great Britain would scarcely have been possible without the help so freely and willingly given to all by Taylor and his staff. As a result of his carefully standardized testing sera, reliable blood grouping results were placed within the reach of all services and hospitals, the volume of serum thus dispensed involved Taylor in a constant struggle to maintain adequate supplies of standard reagents—a work ungrudgingly pursued, the difficulties of which are often inadequately recognized. In spite of so much daily routine, Taylor continued his scientific work and was able to publish a further series of papers on the distribution of blood groups and subgroups in Great Britain based on a very much larger number of tests performed in the Transfusion Services. Taylor was quick to appreciate the scientific importance of the Rh factor, and his appeal with Mollison for samples of blood from the mothers of babies with erythroblastosis met with an excellent response which enabled him to pursue this subject so vigorously that within less than two years he and his collaborators had described seven allelomorphs of the Rh factor and four different types of anti-Rh serum. These results were obtained quite independently of simultaneous studies in America by Wiener, Levine and others, but the work of Taylor and his associates provided a welcome clarification of the confused state of American terminology, and Taylor's name will always be associated with the classification of the allelomorphs of the rhesus factor.

G. L. Taylor was a quiet, unassuming man, always ready to give his time to smoothing away the difficulties of others in what was an abstruse and difficult field. His friendly, helpful personality endeared him to a wide circle of friends, by whom he will be greatly missed. Our sympathy goes out to Mrs. Taylor and her young daughter.

D. F. CAPPELL.

NEWS and VIEWS

Colonial Microbiological Research Institute

THE Colonial Office announces that it has been decided to establish in Trinidad a Colonial Microbiological Research Institute, for the general study of microbiological problems in tropical conditions. The Institute will be under the general supervision of the Colonial Products Research Council, and will be financed from funds provided under the Colonial Development and Welfare Act, 1940. The first Director of the Institute will be Dr. A. C. Thaysen, of the Chemical Research Laboratory, Department of Scientific and Industrial Research.

He has been responsible there for the fundamental work on which a food yeast factory, now in course of erection in Maricao, has been planned. Dr. Thaysen is leaving Trinidad to discuss the siting and construction of the Institute's laboratories and connected matters. It is hoped that, when the Institute is under way, it will be possible to afford facilities for postgraduate work by visiting men of science in addition to the work of the staff of the Institute itself (see also p. 564 of this issue).

Scientific Activities in Paris

DURING the past few months, a few men of science in France have been able to visit Great Britain and to take up again the threads of scientific intercourse. Now we are able to welcome the re-appearance of *La Nature*, the well-known popular journal of science and its applications, after three years of suppression. The first issue, dated January 1, 1945, consists of only sixteen pages, and it is shorn of its attractive cover, but it contains well-illustrated articles on penicillin and its manufacture and on the solar corona, and a useful map of French broadcasting stations with data of their wave-lengths, powers, etc. The Editor announces that the journal will be devoted, as before the War, to the popularization of science, its applications, its methods and its significance for human progress. Later issues are equally attractive, the articles being well illustrated and maintaining a nice balance between pure science and its applications. *La Nature* is being published twice a month at 10 francs a copy. Another sign of increasing scientific activity in Paris is a comprehensive programme of

public meetings arranged by the French Association of Scientific Workers under the auspices of the Centre National de la Recherche Scientifique, which have been going on since early spring. The meetings have been divided into lectures on laboratory technique, public lectures on current scientific topics and visits to laboratories. The programme, which contains more than a hundred entries, reveals an enthusiasm that augurs well for the resurgence of science in Paris.

Physical Society · Presentation of Duddell Medal

At a meeting of the Physical Society to be held at the Royal Institution at 4 p.m. on May 23 the Duddell Medal for 1944 will be presented to Dr F. W. Aston in recognition of his invention and subsequent development of his mass spectrograph. This instrument, first designed and constructed in 1919, made use of a new and ingenious method of electromagnetic focusing and enabled Aston to establish that many elements consist of mixtures of isotopes, as foreshadowed by J. J. Thomson's work on neon. With later modifications of the instrument, Aston investigated most of the known elements and showed that all the stable isotopes, of which he discovered hundreds, had nearly integral masses, taking O as 16. Aston's later work is concerned mainly with the small deviations from this whole-number rule, representing the binding energies of the isotopes in the nucleus. Using a much improved mass spectrograph, he measured masses with a precision of 1 in 20,000 and determined the binding energies in isotopes of the lighter elements with great accuracy. Finally, from the masses and the photometrically determined relative abundances of the isotopes, Aston calculated "chemical atomic weights" for comparison with, and as a check upon, the results of other methods. At the same meeting, Prof. E. N. da C. Andrade will deliver his presidential address, taking as his subject "The History and Future of the Physical Society".

Belgian Delegation in Britain

A SECOND group of Belgian professors, representing the Belgian Fondation Universitaire, is visiting Britain for a fortnight at the invitation of the British Council. For five of them it is their first visit to this country. The delegates are Prof. Jean Brachet, Faculty of Science, Brussels; Prof. Marcel Homes, Faculty of Science, Brussels; Prof. Henri Koch, Faculty of Comparative Physiological Science, Louvain; M. Marius Lecompte, keeper of the Belgian Royal Museum of Natural History; Prof. Jean Louis, State Agricultural Institute, Gembloux; Prof. Victor Van Straelen, Faculty of Science, Ghent, and Brussels; Dr. Pierre Wigny (law and legal science); Prof. Jean Haesaert, Faculty of Law, Philosophy and Letters, Ghent; Prof. Paul Rousseau, Faculty of Law, Louvain; Prof. Paul de Visser, Faculty of Law, Louvain. Among the places the delegation will visit are the British Museum, the Imperial College, Kew Gardens and the Bureau of Micrology, University College, London, the London School of Hygiene and Tropical Medicine, the Society for Visiting Scientists, Rothamsted Experimental Station, Oxford and Cambridge.

Advisory Committee on Building Research

The Minister of Works has appointed a scientific advisory committee to advise on and to suggest lines of scientific research, to suggest where this research could best be carried out and to keep it under review,

and to advise on the practical possibilities and further development of the results of current research. The committee consists of Prof. J. D. Bernal (physics, Birkbeck College, London (chairman)), Dr. E. F. Armstrong, member of Building Research Board, Prof. J. F. Baker (mechanical sciences), University of Cambridge, Prof. P. M. S. Blackett (physics), University of Manchester, Prof. W. E. Curtis (physics), University of Durham, Dr. C. C. Douglas, University of Oxford, chairman, Joint Committee on Heating and Ventilation (Building Research Board and Industrial Health Research Board), Prof. C. D. Ell (physics), King's College, London, Prof. I. M. Hebron (organic chemistry), Imperial College of Science and Technology, London, scientific adviser, Ministry of Production, Prof. J. M. Mackintosh (public health), University of London, Mrs. J. V. Robinson, lecturer in economics, University of Cambridge, Sir Ernest Simon, chairman, Advisory Council, Ministry of Fuel and Power, Mr. F. E. Smith, chief superintendent, Armament Design Dept., Prof. W. N. Thomas (engineering), University College, Cardiff, and Prof. S. Zuckerman (anatomy), Universities of Oxford and Birmingham. Mr. I. G. Evans, director of building research, Lord Amulree, medical officer, Ministry of Health, and Dr. R. S. F. Schilling, secretary, Industrial Health Research Board, are assessors. Sir Reginald Stradling is executive officer.

Release of Requisitioned Land and Premises

THE second report from the Select Committee on National Expenditure for the Session 1944-5 deals with the release of requisitioned land and buildings. It emphasizes the weaknesses in existing land legislation which were stressed during the debate in the House of Commons on the Requisitioned Land and War Works Bill, and shows the need for incorporating in the Bill provisions to amplify the assurances which Sir John Anderson gave to the House of Commons in that debate. An instance cited is the report of an airfield constructed on 600 acres of farm land and 260 acres of common land in the 'green belt', into which the Select Committee inquire shows that existing legislation fails to protect common land or to provide for its reinstatement. The menace to the countryside which still persists is shown by two further examples: the Admiralty's claim to Bodmin Moor, rich in archaeological interest and potentiality for research, and also an important catchment area for use as a bombing range—since dropped—and the War Office inability to say whether the tract between the Frome River and Studland and Swanage Bay, cleared for training purposes, is to be restored to public use.

On the question of premises, the Select Committee's report indicates that the fundamental principle is the same, and its principal recommendation is that a supervisory authority should be entrusted with the task of pressing for the release of requisitioned premises, bearing in mind urgent civilian needs, and a central and independent review of the use of premises and of storage requirements should be instituted and pressed forward with all practical speed. But while a valuable system of co-ordinating the release of requisitioned land and premises has been devised, the little use that has so far been made of it is not to be attributed entirely to departmental reserve or inaction. It is due at least partly to the absence of decisions at the centre. The report recommends that the Government should not only come to an early decision whether it is more

to the national disadvantage to sterilize space by housing surplus stores or to scrap the stores, but also provide the departments, with the least possible delay, with the directions as to the strength and organization of the defence forces required after the War, which will enable them to determine which properties they will need to acquire and which of those now held they will eventually be able to release. Besides, the Select Committee recommends an independent review by the Government of the practice of departments in the retention of stores, and in this connexion the advice of Government scientific and research organizations should be sought in classifying stores according to their probable future use, having regard to scientific progress. The procedure for declaring stores obsolete also requires speeding up, and surplus stores and scrap arising overseas should, wherever possible, be disposed of without being brought back to Great Britain. Subject to political and strategic considerations, the fullest use should be made of storage facilities overseas for stores required for the war against Japan.

Museums as Contemporary Educational Centres

A MEMORANDUM received from Mrs. M. Harrison, acting curator of the Geffrye Museum, London, E.2, deals with the present-day problems of the creative use of leisure in an industrialized society—the education of children of a non-academic turn of mind, and the bridging of the gap that still tends to lie between school and the actualities of life. It is suggested that the solution lies in the establishment of centres specially equipped to show the individual, on a scale within his grasp, his place, meaning and purpose within the contemporary world. These centres could present in an appropriate manner a variety of visual material culled from industrial, commercial and public sources. They could also provide for courses of instruction in art and craft work and in contemporary social studies, educational film shows, facilities for study, and a scheme for loans to schools, with the view of encouraging further the individual's practical interest in, and investigation of, his or her surroundings in relation to the world at large.

Most of the plan is very feasible—indeed, several of the methods advocated have for some time been in successful operation in the 'village colleges' of Cambridgeshire; but it is difficult to accept the suggestion that it would be possible "to show the contemporary world . . . the direction in which the whole world is moving", either for reasons of exhibition space, or of opinion. There is much within it, however, which might well claim the attention of 'centres' already in existence, such as the larger provincial museums. For example, some of these in presenting the geology of their various areas are already 'illustrating' the fundamentals (not mentioned in the plan) inseparable from some industries. Upon such foundations the institutions concerned might profitably build along the lines suggested, and thereby help to refute the accusation (recently made at a meeting of the British Association) that the majority of museums in Great Britain are 'out of touch with modern life'.

Burrell Art Collection for Glasgow

THE Corporation of the City of Glasgow reports this important acquisition in its Art Gallery and Museums Report for the year 1943-44. Sir William Burrell's collection, which consists of pictures, tapestries, stained glass, furniture, carpets, porcelain,

ivories, enamels and silver, has long been associated with his name. It is probably most widely known for its tapestries, which include many of international importance. While presenting this valuable material for the cultural benefit of Glasgow, the donor has at the same time made provision for the purchase of additional works of art (more especially for those of the Gothic period), and for a special building to house it. This building will eventually be erected in the country not less than sixteen miles from the city.

Cancer Control in Peru

THE August issue of the *Boletín de la Oficina Sanitaria Panamericana* contains an interesting article on this subject by Dr. Julio Bedoya Paredes, of the National Institute of Radiology of Peru, who states that since this Institute was founded two years ago a record has been kept of cases according to the site of the cancer, classification, treatment and results. The Institute includes a reception service, specialized clinics, such as gynaecology, surgery and internal medicine, X-ray, basal metabolism, laboratory and histopathology sections, statistical, health education and preventive sections. It is intended to create a biopsy service through which specimens may be sent by air to the Institute for diagnosis.

Announcements

DR. J. F. J. DIPPING, head of the Chemistry Department at the Mining and Technical College, Wigan, has been appointed head of the Science Department at the South-East Essex Technical College, Dagenham.

To encourage the reading of papers by student members of the Institute of Fuel, also those taking courses at universities and technical colleges, the Council has decided to make an annual award of a medal together with a prize consisting of books and instruments to the value of £5. Particulars can be obtained from the Secretary, Institute of Fuel, 30 Bramham Gardens, London, S.W.5.

At the anniversary meeting of the Royal Institution held on May 1, the following officers were elected: *President*, Lord Rayleigh; *Treasurer*, Sir Robert Robertson; *Secretary*, Dr. A. O. Rankine; *Managers*, Prof. E. N. da C. Andrade, Dr. F. H. Carr, Sir Charles Darwin, Prof. Herbert Dingle, Dr. P. Dunsheath, Viscount Falmouth, Prof. G. I. Finch, Prof. C. L. Fortescue, Captain H. L. Hitchins, Mr. James Kewley, Mr. Arthur Marshall, Prof. H. R. Robinson, Dr. G. Shearer, Mr. H. S. Souttar, Sir George Thomson; *Visitors*, Brigadier R. A. Bagnold, Mr. J. G. Bennett, Mr. M. G. Bennett, Major W. H. Cadman, Dr. W. H. J. Childs, Mr. F. P. Dunn, Mr. Kenneth Gray, Dr. Wilfred Hall, Mr. James Henshilwood, Dr. W. Jevons, Mr. L. B. W. Jolley, Mr. G. S. W. Marlow, Prof. L. C. Martin, Mr. E. Kelly Maxwell, Prof. H. J. Plenderleith.

A COURSE of six lectures on "The Problem of Freedom in a Planned Society" to be delivered on Wednesdays, beginning May 16, at 7.30 p.m., at Victory House Hall (N.S.P.C.C.), Leicester Square, London, W.C.2, has been arranged by the Progressive League. The speakers include Prof. H. Levy, Major Adrian Stephen, Prof. M. Polanyi, Prof. F. A. Hayek, Dr. C. A. Smith, and Prof. D. Mitrany. Tickets, 6s. for the course, 1s. 6d. for single lectures, can be obtained from the secretary of the Progressive League, 20 Buckingham Street, London, W.C.2, or at the door.

LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications.

Extra X-Ray Reflexions from Diamonds

Dr. R. S. Krishnan and Mr. G. N. Ramachandran have stated¹ that they are not able to confirm my observations on type II diamonds, and they conclude that "The objections which Mrs. Lonsdale has raised against the interpretation of the X-ray reflexions observed with diamond given by the Bangalore workers are thus believed to be without experimental foundation".

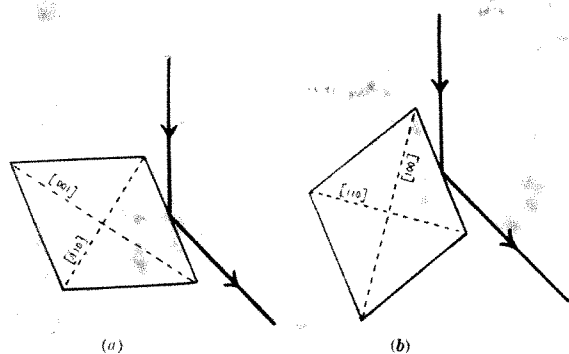


Fig. 1.

Two years ago, however, Sir C. V. Raman, after stating his theory, continued: "The appearance of the quantum X-reflections with one kind of diamond and their non-appearance in the other kind then follows as an immediate consequence. In other words, this difference in X-ray behaviour of the two kinds of diamond is actually a proof . . ."² I am afraid that the Bangalore workers cannot have it both ways. If the difference in the two types of diamond is an immediate consequence of Raman's theory, then Krishnan and Ramachandran's denial that any such difference really exists does not support the theory, but contradicts it.

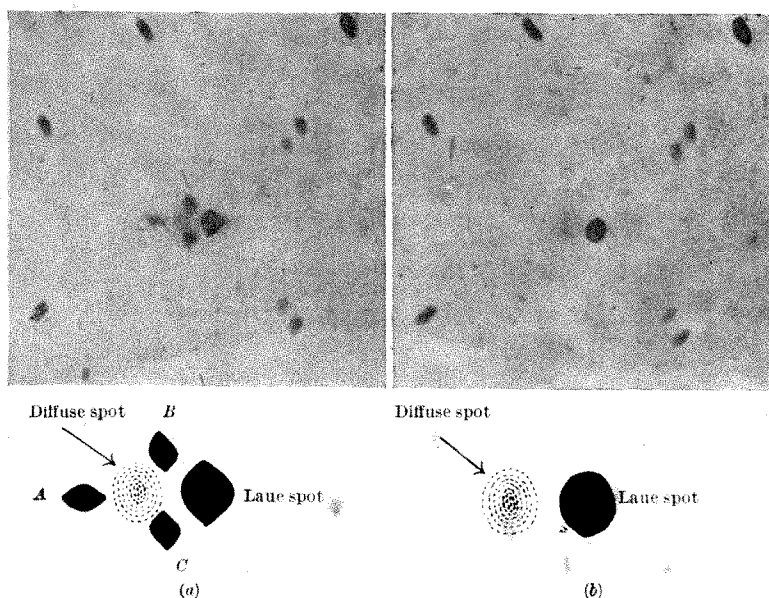
I am not concerned, however, with proving or refuting a theory; at this stage, facts are more important. As I understand their letter, Krishnan and Ramachandran have found a group of three extra spots for type I diamonds, whereas for type II diamonds they have found only one extra spot. This spot is rather diffuse; but coincides in position with the strongest of the three type I spots. They conclude that it is, in fact, the same spot. These data show that the diamond orientation used in their experiments was as shown in Fig. 1(a), the $[1\bar{1}0]$ axis being vertical (normal to the plane of the diagram) and the angle of incidence near the Bragg angle. I fully agree that in this orientation, the positions of the sharp spot found only for type I and of

the diffuse spot found for all diamonds are nearly identical (see p. 317, paragraph (6) and Plates 35f, 38d, and 39d of my paper³). In type I diamonds the diffuse spot forms a background to the sharp spot; in type II diamonds it exists alone; but without the evidence of the accompanying streaks or streaky spots, it is certainly difficult to distinguish the two effects.

If the diamond is turned through 180° about the normal to the (111) reflecting plane, however, so that its orientation is as shown in Fig. 1(b), no such possibility of confusion arises. The X-ray effects found in this orientation are as shown in the photographs and explanatory diagrams (Figs. 2a and 2b).

In this orientation the diffuse spot found for type II diamonds is clearly *not* equivalent to any of the three extra type I diamond spots A, B or C. It differs from them in intensity, shape, diffuseness, behaviour with change of temperature and of crystal mis-setting from the exact Bragg angle. It becomes larger and much more diffuse as the mis-setting increases, whereas the three type I spots A, B, C become slightly smaller and remain sharp. It is also temperature-sensitive, and they are much less so. This diffuse spot found for type II diamonds corresponds in all respects with the diffuse spot found at the centre of the A, B, C group for type I diamonds in orientation (b), except that it is more intense, because type II diamonds are inherently better reflectors. I have taken more than six hundred Laue photographs of various diamonds and have confirmed these observations again and again. The similarity between the diffuse (thermal) spots in the two types of diamond and the entire absence in type II of the sharp extra spots characteristic of type I photographs has been proved not only for the $\{111\}$ reflexions but also for $\{220\}$ $\{113\}$ reflexions in various orientations.

Krishnan and Ramachandran say that their type II diamond diffuse spot was very little temperature-sensitive. I offer the following explanation. Type II diamonds are not only mosaic, but also they often show definite distortion, such as slight spiralling of



Type I diamond: orientation as in Fig. 1b.

Type II diamond: orientation as in Fig. 1b.

Fig. 2.

the crystallites⁴. The result of this distortion is that although the real diffuse spot does vary with temperature, it is sometimes partially overlaid by a sharper and more intense distortion spot which does not vary with temperature. Using a large crystal and big X-ray beam, as Krishnan and Ramachandran appear to have done, it is easy (in orientation Fig. 1a) to confuse this sharp distortion spot with the sharp spot found for the near-perfect type I diamonds. They occur in the same place. In orientation (b) this confusion is quite impossible, especially if a really fine X-ray beam is used, so as to obtain maximum resolution. I suggest that Dr Krishnan and Mr Ramachandran should turn their diamonds through 180° about the normal to the reflecting (111) plane and test orientation (b) using a $\frac{1}{2}$ -mm diameter cylindrical collimator, and that they should look for the {220} and {113} effects in the two types of diamond and compare these also. I think that this controversy about a question of experimental fact would then cease.

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March 9

¹ Krishnan, R. S., and Ramachandran, G. N., *Nature*, 155, 234 (1945)

² Raman, C. V., *Curr. Sci.*, 12, 40 (1943)

³ *Proc. Roy. Soc. A*, 179 (1942)

⁴ Lonsdale, K., *Mineral Mag.* (in preparation)

Frictional Properties of Wool Fibres

THE friction apparatus devised by Bowden and Leben¹ to examine the friction of metals has been used to study the frictional properties of wool fibres. Some accessories were made to adapt the apparatus to the application of loads of 0.05–1 gm and the measurement of small frictional forces, but in essentials it remains the same as described by the above authors. The modifications enabled a single fibre mounted in a bow to be carried forward with a speed of 0.01 cm sec⁻¹ while pressed against a cylindrical piece of ram's horn with the required load. The horn was mounted on a strip of clock spring, the deflexion of which, recorded photographically by a moving-film camera, was a measure of the frictional force.

'Stick-slip' phenomena similar to those previously obtained¹ were recorded. The with-scale and anti-scale directions along the fibre were readily distinguished by the magnitude of the frictional force and the character of the stick-slips (see graphs a and b). The effect of wetting the fibre could be studied easily. Particular attention was paid to the variation in the two coefficients of friction (μ_1 and μ_2) with the pH of the wetting fluid, and to the effect of treating the fibre with shrinkage-reduction processes.

Typical values for the coefficients (horn-wool) obtained under several conditions are given in the accompanying table.

Speakman and Stott² have used the quantity $\frac{\mu_2 - \mu_1}{\mu_1}$ to give a measure of the tendency of individual fibres to undergo unidirectional migration which is recognized as the cause of wool felting and garment shrinkage. In view of the considerable difference between μ_2 and μ_1 , a directional coefficient defined by $\frac{\mu_2 - \mu_1}{\mu_2 + \mu_1}$ is preferred here. The directional

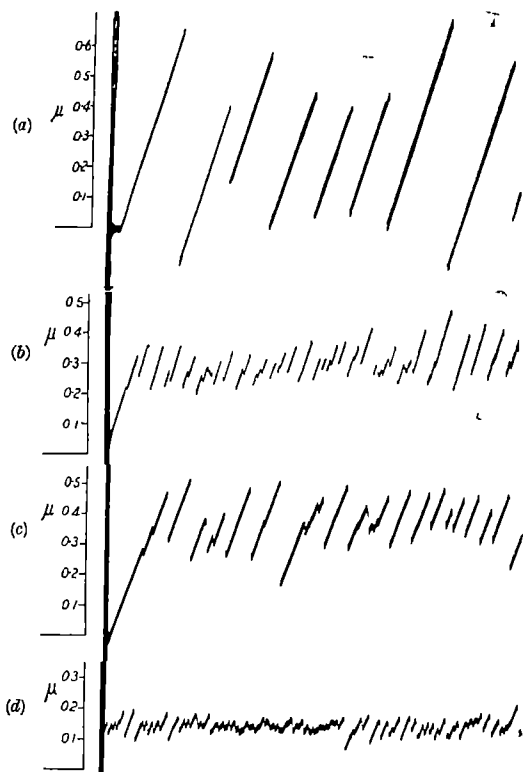
TYPICAL VALUES FOR COEFFICIENT OF FRICTION (WOOL ON HORN)
LOAD, 0.20 GM μ_1 WITH-SCALE COEFFICIENT, μ_2 ANTI-SCALE COEFFICIENT

No	Sample	Conditions	μ_2	μ_1	Directional coefficient
1	Normal coarse merino	air dry	0.5	0.3	0.2
		wet pH 4	0.6	0.3	0.35
		" pH 10.8	0.6	0.2	0.45
		" pH 1.3	0.7	0.3	0.4
2	*Chlorine treated wool	wet pH 4	0.1	0.1	0.0
		" pH 10.8	0.02	0.02	0.0
		" pH 1.3	0.1	0.1	0.0
3	*Bromine treated wool	wet pH 4	0.25	0.2	0.1
		" pH 10.8	0.05	0.05	0.0
		" pH 1.3	0.15	0.15	0.0
4	*Alcoholic caustic potash treated wool	wet pH 4	0.6	0.4	0.15
		" pH 10.8	0.5	0.35	0.15
5	*Sulphuryl chloride treated wool	wet pH 4	0.7	0.65	0.05
		" pH 10.8	0.45	0.4	0.05
		" pH 1.3	0.9	0.8	0.05

* Treatments commonly used to reduce the shrinkage of woollen goods

coefficient is increased by wetting the fibre, and the increase is greater in acid and alkaline than in neutral media (see Table, No. 1). The rate of felting is also greater both in acid and alkaline solutions than in neutral. Speakman, Stott and Chang³ have attributed this to the increased extensibility of the fibres in such solutions, but it is probable from these results that the increased directional friction also contributes.

As can be seen from the table, Nos. 2–5, shrinkage-reduction processes reduce the directional friction in alkaline solutions. This would cause a reduced rate of felting and would account for their effect in



STICK-SLIP TRACES OF WOOL FIBRE ON HORN

(a) Dry wool against scales (b) Dry wool with scales (c) Wool wet with water, pH 10.8, against scales (d) Wool wet with water, pH 10.8, with scales.

reducing the shrinkage of woollen goods 'Wet' chlorine and bromine treatments reduce the directional friction in alkaline media by decreasing both μ_1 and μ_2 to low values. Sulphuryl chloride treatment makes μ_2 approach μ_1 without greatly reducing the average friction. Alcoholic potash treatment increases both μ_1 and μ_2 in alkaline solution to approximately the same value.

In these preliminary experiments, horn was chosen as the second rubbing surface because it is chemically similar to wool and is more convenient to handle. A few experiments with wool fibre against wool fibre gave essentially the same results. Further work on this problem is continuing.

The above was written before I had an opportunity of seeing the recent communication by Whewell, Rigelhaupt and Selim⁴. These authors, using an 'angle of slip' method of measuring friction, have demonstrated changes in directional friction or scaliness. Our conclusions are in agreement, except that they find a decreased directional friction in alkaline solutions. This may be due to the fact that their determination was made at pH 9.24. I have previously reported that under some conditions a minimum rate of felting occurs at this pH with an increased rate at higher pH's⁵.

My thanks are due to Drs F. P. Bowden and D. Tabor for permission to use the facilities of the Lubricants and Bearings Section of the Council for Scientific and Industrial Research, and to Dr Tabor for help in discussion.

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Feb 5

¹ *Proc. Roy. Soc., A*, 169, 371 (1939).

² *J. Text. Inst.*, 22, T 339 (1931).

³ *J. Text. Inst.*, 24, T 273 (1933).

⁴ *Nature*, 154, 772 (1944).

⁵ *J. Council Sci. Ind. Res. (Aust.)*, 15, 285 (1942).

Radioactivity of the Neutron

THE mass of the neutron (1.00893 m μ) is about 0.8 Mev greater than that of the hydrogen atom (1.00813 m μ). We should expect that, from Fermi's theory, the neutron would be β^- -radioactive with a half-life period of about three hours, if the transition is not 'forbidden'. The fact that this radioactivity has never been actually observed is attributed to the extremely short life of the capture of the neutron by nuclei through which the neutron is passing (about 1.7×10^{-4} sec in paraffin). We here propose a method which may be capable of detecting the decay of the neutron.

Let a strong source of neutrons be put near a paraffin block, and let the neutrons, after being slowed down by paraffin, be incident on a vessel containing partly liquid heavy hydrogen. Since the neutron capture cross-section ($\sigma_c = 2 \times 10^{-28}$ cm²)¹ in the deuteron of the deuterium is only about one-thousandth of that of the nuclei in paraffin, we should expect the capture life-time for the slow neutrons of the former to be about one second. Within this time there is a measurable probability of the decay of the neutron. Thus the vessel containing liquid heavy

hydrogen, being exposed to slow neutrons for a certain time, must also contain hydrogen as the decay product of neutrons. The presence of these hydrogen atoms may be detected spectroscopically.

It may also be mentioned that the use of liquid helium instead of liquid heavy hydrogen would probably give better results, because the value of σ_c for neutrons in helium is probably smaller than in deuterium, although there is no experimental evidence for this up to the present.

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¹ Borst, L. B., and Harkins, W. D., *Phys. Rev.*, 57, 659 (1940).

A Simple Calculation of the Perihelion of Mercury from the Principle of Equivalence

IT is known that first-order phenomena described in the general theory of relativity can be deduced from the principle of equivalence. The present note serves as an illustration.

The principle of equivalence demands that the length along the field direction be deviated, to the first order of approximation, in the ratio $dr/(1 + \lambda/r)dr$, where λ is GM/C^2 , and that the time, dt , be modified into the expression $(1 + \lambda/r)^{-1}dt$. But the length normal to the field direction undergoes no change.

Hence the kinetic energy is expressible in the form $\frac{1}{2}(\beta^2 r^2 + \beta^2 \dot{\theta}^2 r^2)$ and the Lagrangian is accordingly $\frac{1}{2}(\beta^4 r^2 + \beta^2 \dot{\theta}^2 r^2) - V(r)$, where $V(r) = -GM/r$, $\beta = (1 + \lambda/r)$.

Now the equation of motion of a test body is

$$\frac{d}{dt}(\beta^4 r) - \beta^2 r \dot{\theta}^2 - 2r^2 \frac{\partial \beta}{\partial r} - r^2 \dot{\theta}^2 \frac{\partial \beta}{\partial r} + \frac{\partial V}{\partial r} = 0, \quad (1)$$

$$\beta^2 r^2 \dot{\theta} = h (= \text{const.}), \quad (2)$$

where β denotes $(1 + \lambda/r)$.

Retaining only the first order of λ , we have from (1) and (2):

$$-\frac{h^2}{r^2 \beta^2} \frac{d}{d\theta} \beta^2 \frac{d\mu}{d\theta} - \frac{h^2}{\beta^2 r^2} \mu = -GM\mu^2 - h^2 \mu^4 \lambda + 2r \frac{\partial \beta}{\partial r},$$

$$\text{or } \frac{d}{d\theta} \beta^2 \frac{d\mu}{d\theta} + \mu = \frac{GM}{h^2} \beta^2 + \lambda \mu^2 - 2 \frac{r^2 r^2}{h^2} \frac{\partial \beta}{\partial r}.$$

$$\text{But } \frac{d}{d\theta} \beta^2 \frac{d\mu}{d\theta} = \beta^2 \frac{d^2 \mu}{d\theta^2} - 2 \frac{r^2 r^2}{h^2} \frac{d\beta}{dr},$$

$$\text{hence } \frac{d^2 \mu}{d\theta^2} + \beta^{-2} \mu = \frac{GM}{h^2} + \lambda \mu^2,$$

$$\text{or } \frac{d^2 \mu}{d\theta^2} + \mu = \frac{GM}{h^2} + 3\lambda \mu^2$$

This is the same equation as that obtained from Schwarzschild's solution and the geodesic equation of a test body.

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May 27, 1944.

Spectrophotometric Determination of Vitamin A in Fish Oils

THE purpose of this note is to show that when the vitamin A content of a fish oil has been determined spectroscopically, the result should be expressed in mgm vitamin A per gm of oil $E_{1\text{ cm}}^{1\text{ per cent } 328\text{ m}\mu}$ could also be stated. In this laboratory we have had experience of the confusion that is rife in commercial transactions and investigational surveys when the results of the spectroscopic estimation of vitamin A in fish oils are expressed in IU/gm , and we seek the co-operation of chemists in the removal of this source of confusion. $E_{1\text{ cm}}^{1\text{ per cent } 328\text{ m}\mu}$ (hereinafter referred to for short as the extinction E) is a physical property of an oil which can be measured to an accuracy of 2 per cent on a suitable ultra-violet spectrophotometer. For the estimation of vitamin A, extinction is taken as proportional to the concentration of vitamin A. The use of the extinction to express vitamin A content has the advantage of unequivocal meaning for the chemist, but does not convey to dealers or consumers a clear indication of the concentration of vitamin A in the oil. A 'conversion factor' by which the extinction is multiplied to give the vitamin A content in IU/gm has been used in an attempt to overcome this difficulty. The attempt has failed because researchers and industrial laboratories in different countries use widely different 'conversion factors' ranging within the range of 1400 to 3000. Thus the British Pharmacopoeia uses the factor 1600, Morton¹ states "In the U.S.A. the 'conversion factor' of 2150 is commonly used." Baxter and Robeson² find values between 2350 and 3160 depending on the conditions, and a recent determination by the Advisory Committee to the British Pharmacopoeia reported by Mead³ gives the value 1740 as the best value for 'conversion factor'. The reasons for this unfortunate situation are discussed by Morton¹ and Hume⁴; the result is that the vitamin A content of oils from different sources cannot be deduced from the potency in IU/gm stated on the labels of the containers—a situation which causes mistakes and admits of misrepresentation in commercial dealings. A solution to the problem of clearly stating the vitamin A content is obtained if the extinction is multiplied by a factor to give the result in mgm vitamin A per gm of oil. Such a factor is known to

an accuracy of ± 3 per cent, which is within the error normally expected in the spectroscopic assay of fish oils. The factor required to convert E oil to

mgm vitamin A per gm. oil is $\frac{1000}{E_{\text{pure vit A}}}$

Measurements of $E_{\text{pure vit A}}$ which have been recorded in the literature since 1933 are noted in Table 1

TABLE 1 EXTINCTION (AT THE MAX NEAR 328 M μ) OF VITAMIN A ALCOHOL IN ETHYL ALCOHOL

Date	$E_{1\text{ cm}}^{1\text{ per cent}}$	Notes on sample	Ref
1933	1600	Non-crystalline concentrate prepared by molecular distillation	4
1933	1700	Non-crystalline concentrate prepared by molecular distillation	5
1934	1600	Non-crystalline concentrate prepared by molecular distillation	6
1937	2100 falling to 1800 on standing	Crystalline, containing methyl alcohol of crystallization	7
1939	1800	Crystalline	8, 9
1942	1760 ± 21	Nine samples of crystals	2
	1780	One sample, checked photoelectrically by Zscheile, F.P. (3 determinations)	2

Recent values for E of pure vitamin A alcohol in ethyl alcohol are covered by the figure 1780 ± 50 . This figure should be used for the estimation of non-saponifiable extracts. In fish oils, vitamin A is present as an ester. From Table 2, which lists the effect of esterification and solvent, a reduction to 1750 ± 50 is indicated. This figure should be used when the estimation is performed without prior saponification of the oil.

The chief error in the spectroscopic assay is the presence of irrelevant absorption at 328 m μ . Some estimate of the extent of irrelevant absorption may be obtained by noting the shape of the absorption spectrum, but no precise method of eliminating this error is known. It is more serious for low- than for high-potency oils. Saponification removes most of the irrelevant absorption, but involves a loss of vitamin¹⁴. These sources of error make the spectroscopic estimation of vitamin A in fish oils less accurate than the 2 per cent error normally allowed in the measurement of extinction. An uncertainty of 3 per cent in the conversion factor does not, therefore, make it unacceptable. It is absurd to use a factor which commonly has an uncertainty of 30 per cent and in extreme cases almost 100 per cent, as has the factor used to convert the extinction to IU/gm .

TABLE 2 EFFECT OF SOLVENT AND ESTERIFICATION OF THE EXTINCTION OF VITAMIN A.

In the following table is given the ratio of the extinction of the ester in a given solvent to that of an equivalent amount of vitamin A alcohol in ethyl alcohol. The extinction of vitamin A alcohol in alcohol is taken as 1,780 for the purpose of this table. Irrelevant absorption has been subtracted where necessary.

Solvent	Vit A alcohol	Non-sap content	Palmitate	Fish oils	β -naphthoate	Anthraquinone 2-carboxylate	Acetate	Succinate
Alcohol	1.00	1.00 S	0.97 B	0.97	0.92 B			
Isopropyl alcohol	0.98 Z				0.995 M		0.97 B	0.80 B
Cyclohexane	0.93 Z	0.97 S		0.98 S	1.00 H	0.995 M		
	0.88 B	0.89 A			1.09 H (+ 10% arachis oil)			
Hexane	0.98 Z	0.97 S	0.94 Z(?)*		0.95 H (+ 100% " ")			
iso-octane	0.96 Z		0.98 Z(?)*					
Ether	1.03 Z	1.07 S	1.00 Z(?)*	1.09 S				
Chloroform	0.83 G	0.86 S		0.90 S				
		0.71 B						
Ethyl alcohol		1.03 Z						
Ethyl formate		0.96 Z						
Benzene		0.83 G						
Styrol ether		0.91 G						
		0.99 B						

* For the calculation of these ratios the assumption is made that

$$\frac{E_{\text{Palmitate}}}{E_{\text{Ether}}} = \frac{E_{\text{Vit. A alcohol}}}{E_{\text{Ether}}}$$

$$\frac{E_{\text{Palmitate}}}{E_{\text{Alcohol}}} = \frac{E_{\text{Vit. A alcohol}}}{E_{\text{Alcohol}}}$$

These ratios are deduced from the following authors: A, Adamson and Evers¹⁰, B, Baxter and Robeson², G, Gillam and El Ridi¹¹, H, Hume⁴, M, Mead, Underhill and Coward³, S, Smith¹², Z, Zscheile and Henry¹³.

We, therefore, urge that this practice be discontinued, and that results of the spectroscopic estimation of vitamin A in fish oils be expressed in mgm vitamin A per gm of oil. For the convenience of analysts, and as an indication of the basis of the estimation, $E_{1\text{ cm}}^{1\text{ percent}}$ 328 m μ should also be stated.

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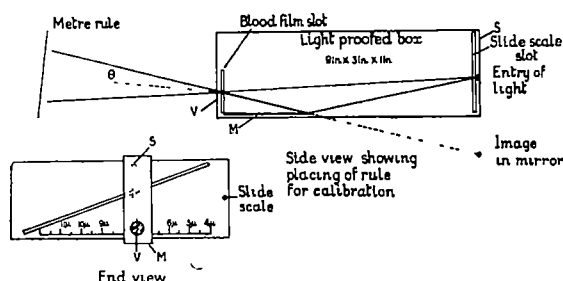
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- ¹⁴ Jones, J I M, and Haines, R T, *Analyst*, 68, 1 (1943)

Apparatus for Measuring Mean Cell-Diameters in Blood Film

A VARIANT on the halometer for the measurement of mean cell-diameters in blood films was constructed recently in a laboratory in the Middle East. As it is easy to construct, very portable and independent of darkened room and electric battery, it may be of some interest.

The feature which makes the adjustment simple and sturdy but precise is a sliding scale which carries a diagonal slit across a slit cut in the end of a light-proofed box. Thus light can only enter the box where the two slits intersect, and as the slide-scale is moved across the slit in the end of the box, this point of entry is seen to move along the end of the box at a speed governed by the angle of the diagonal slit in the slide-scale. At a suitable angle the adjustment can be made as fine as is desired. The use of a mirror inside the box provides a companion to this point of light in the box, moving in the opposite direction. The pair gives the two required diffraction patterns the proper juxtaposition of which gives the measurement reading on the scale.

The apparatus consists of a light-proofed box (9 in. $\times$ 3 in. $\times$ 1 in., a common size of tin here was found to be very convenient), a microscope slide (when blackened on one side to obviate double reflexion this makes an excellent mirror), a rectangular sliding piece as wide as the box (made to fit in or on the lid of the box when not in use, its sides should not wear too easily).



A slit S is made along most of the length one end of the box. In the top and bottom just behind this end, slots were cut to fit the slide-scale piece, so that when this is in position it completely prevents light from entering the box through the slit. A smooth microscope slide M was painted black on one side and fitted to the narrow side of the box reaching to within $\frac{1}{4}$ in. of the other end. In the end near the mirror a round viewing-hole V 6 mm across with the nearest edge 2 mm above the plane of the mirror was cut. Slots suitable to take the blood films were made in the top and bottom just behind the viewing-hole. The slot in the slide-piece was cut at a small angle to the length of the rectangle, but sufficient to give a range of movement to the point of entry of the light from 2 cm to 7 cm above the plane of the mirror. It is convenient to make the length of this piece such as to fit in or on to the end of the instrument. A curved spring strip to steady the slide in its slots may be considered necessary to eliminate variations in the readings. The measurements gave a range of reading from 5 to 11 microns. The inside of the box was blackened to exclude stray reflexions with their extra haloes.

Calibration can be done in many ways. The principle of the halometer relates the angle 2θ of separation of the two diffraction patterns to the predominant cell-diameter M according to the relation:

$$\sin \theta = N/lM,$$

where l is wave length of light used (usually 0.6 microns, in the middle of the red), N is order of reflection from centre of system (usually 2).

It is required to mark the positions of the slide-scale where the measurement of this angle corresponds to various suitable values of M . It is convenient to make the marks where the scale enters the box, the viewing-hole side of it. In this manner it is possible to observe the diffraction patterns with one eye while watching the reading with the other.

A suitable method of measuring the required angle accurately is to place the instrument on a table in a dark room with the slide-scale projected over the end of the table and the slit illuminated with bright diffuse light, for example, a 'pearl' bulb. The instrument should always be used with a diffuse source of light such as a lighted wall, daylight or 'pearl' bulb, as the light entering the box has to illuminate the viewing-hole directly and via the mirror simultaneously. With the instrument in the above position, a pin is placed vertically in the box intended for the blood films centrally to the viewing-hole. Two shadows of the pin are now outlined on the viewing-hole, and can be received on a screen or better still a metre rule, which should be placed at right angles to the line from the pin to the point between the two shadows. As the angle between the rays striking the pin is the same as the angle between the shadows thrown by them, the angle of separation between the two lights at the pin can be measured. In fact, the ratio between half the distance between the shadows on the screen and the distance from the rule to the pin is the tangent of the angle θ the sine of which is given by equation (1). Putting in the usual figures, we then write:

$$\text{Half distance between shadows} = \text{distance of rule from pin} \times \sin^{-1} 1.3$$

A table according to these figures is appended. The first column gives the reading for the predominant cell-diameter and the second gives

oper separation of the shadows on a rule at 100 cm in the pm

Cell-meter (microns)	Distance between shadows at 100 cm	Cell-diameter (microns)	Distance between shadows at 100 cm
4	69.4 cm	8½	31.0 cm
4½	62.5 "	9	29.3 "
5	54.3 "	9½	27.9 "
5½	49.0 "	10	26.4 "
6	44.7 "	10½	25.2 "
6½	40.9 "	11	24.0 "
7	38.1 "	11½	22.9 "
7½	34.9 "	12	22.0 "
8	33.2 "		

The technique is insert a suitable blood film and, mounting the instrument at a diffuse source of light, adjust the separation of the coloured rings until a second red rings in each system touch, and then read off on the scale. It is important that the film well covered to give a bright spectrum, but there could not be much overlap as the reading represents a predominant diameter of object on the slide (not an arithmetic mean). Two or three films should be examined as a check, approaching the end point on each side in each case. The degree of anisotropy is represented by the spread of the component spectra, that is, of the spread between the outer red and the smaller cells and the inner violet of the larger cells. In rare cases of anaemia with high degree of isocytosis the method is completely vitiated by clumping.

MARY HOG BEN

1 Field Bacteriological Unit,
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M E F Dec 29

Sorption of Fumigants

WORK recently published by Lubatti¹ and by Winteringham² and experiments still in progress in the Imperial College seem to give some insight into the mechanism of the sorption of organic vapours, and as fumigants, on wheat.

Fumigants are sorbed by wheat very slowly. Three main factors are involved, (a) permeability of the seed coats, (b) diffusion and sorption in the endosperm, (c) chemical reactions which may take place in the tissues of the grains. The seed coats form a continuous envelope relatively impervious to gases, and they appear to be the main factor controlling sorption. In wheat which has been deprived by rationing of the seed coats, sorption appears to be of the same order as that in ground wheat.

The investigations of Barrer and Rideal³ and those of Wicke⁴ have established that in certain sorbents the rate of sorption is governed by the laws of diffusion. This is true in wheat with vapours which do not undergo a chemical decomposition or are only slightly reactive. Examples of such vapours are those of ethylene dichloride and hydrogen cyanide. Equilibrium with these is substantially reached in 15–20 days, and the experimental curves follow closely those calculated from Fick's law.

The forces which retain ethylene dichloride and hydrogen cyanide in wheat are predominantly physical (van der Waals). Accordingly, sorption increases with increase in temperature. It has also been found that the amount of fumigant sorbed is approximately the same at any time-concentration product, whether the concentration is kept constant or allowed to fall, provided that the average concentrations are the same.

Other vapours, such as those of ethylene oxide, react with the constituents of the wheat grains. The

reaction does not usually take place with one specific chemical compound. Many constituents of the tissues take part in the process, in which enzymic action may also assist. The rate of decomposition of the fumigant in the course of these reactions is apparently unimolecular. This may be due to the slowest process being diffusion through the tissues of the grain. The analogy between diffusion through polymers and unimolecular reactions has been pointed out by Barrer⁵. When sorption of the vapour is accompanied by chemical reaction, equilibrium is not approached even after several days. The curve representing the rate of sorption results from the superposition of two or more curves. With ethylene oxide there is a definite curvature towards the time axis during the first twenty-four hours, while physical forces are predominant, but later the curves straighten out and rise rapidly with time as the chemical action proceeds. It is during this period that the rate of diffusion through the tissues is probably the limiting factor. It would appear that these complex changes cannot be represented by mathematical expressions which would apply to more than one system.

With chemically active vapours, sorption increases with an increase in temperature. The time-sorption curve, calculated from experiments carried out with falling concentration, gives lower values than those obtained in experiments performed at an equivalent even concentration. Benton's work⁶ has shown that the velocity of chemical reactions at constant volume is not the same as that occurring in flow systems.

The sorption isotherms at a steady concentration, within the range of concentrations examined, appear to be rectilinear. As equilibrium is not rapidly reached, the so-called isotherms must be represented by a family of rectilinear curves arranged fanwise, the slope of the curves increasing with time. There appears to be a striking analogy between sorption by wheat and permeation through membranes. The work of Daynes⁷, Barrer⁸ and others has shown that the rate of activated diffusion of gases through membranes of organic polymers is linearly related to the difference of pressure established between the surfaces of the membrane.

An increase of the moisture contents of wheat brings about an increase of sorption with all the fumigants studied. This also may be connected with changes of permeability and structural rearrangements in the tissues of the wheat grain. Moisture content is a factor as important as time, concentration of vapour or temperature. A clearer view of the sorption of vapours by wheat is obtained when the 'isohydrotherms' are represented by tridimensional graphs showing the amount of vapour taken up against the changes of concentration and time.

A fuller account of the experiments referred to in this letter and the conclusions which can be drawn from them will be published elsewhere.

O F LUBATTI

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London, S W 7 March 8

¹ Lubatti, *J Soc Chem Ind*, 63, 257 and 353 (1944)

² Winteringham, *J Soc Chem Ind*, 63, 144 (1944)

³ Barrer and Rideal, *Proc Roy Soc, A*, 149, 231 (1935) Barrer, *Proc Roy Soc, A*, 149, 253 (1935)

⁴ Wicke, *Koll Z*, 86, 167 (1939)

⁵ Barrer, "Diffusion in and through Solids" (Cambridge Univ Press, 1941)

⁶ Benton, *Ind Eng Chem*, 19, 494 (1927) and *J Amer Chem Soc*, 53, 2984 (1931)

⁷ Daynes, *Proc Roy Soc, A*, 97, 286 (1920)

Effects of Sodium Thiocyanate on the Development of Amphibia

In previous work it has been shown that the notochord of embryos of *Rana esculenta* L., which from the late blastula stage onwards have been kept in solutions of 0.5–1 per cent sodium thiocyanate for 12–48 hr., appear hyperdeveloped in comparison with the controls¹. The same effect can be observed in embryos of the axolotl of *Amblystoma tigrinum* Green (= *A. mexicanum* Cope) and likewise in lampreys (*Petromyzon* [= *Lampetra*] *planeri* Bl.). A similar effect occurs under the influence of sodium iodide, vital dyes (pyocyanin, methylene-blue) and parantrophol². Some details of the alterations in development produced by sodium thiocyanate are given below.

The hyperdevelopment of the notochord characteristic of the influence of sodium thiocyanate becomes evident through enlargement of the area of cross-section of the notochord. Often, especially when the experimental larvae are shorter than the controls, the notochord folds up. In these larvae the notochord is longer than the body. From a comparative estimate of the volume of the notochord one finds, for example, in a larva of *Rana esculenta* (Fig. 2) originating from a blastula kept in 0.5 per cent solution of NaSCN $2H_2O$ for 48 hr., a volume of $86 \times 10^6 \mu^3$ as against $48.5 \times 10^6 \mu^3$ in the control (Fig. 1). This increase in volume is due to an increase in the number of cells already present in the rudiment of the notochord. In fact, as soon as the notochord is well defined, we have counted 1,561 cell-nuclei in the notochord of an embryo kept for 24 hr. in 0.5 per cent solution of sodium thiocyanate as against 1,090 in the control. When treated after neurulation, but before the tail-bud stage, one obtains larvae with a notochord which is enlarged in the tail, but normal in the trunk.

Parallel to the increase in the dimensions of the notochord are phenomena of hyperevocation. In several embryos a large mass of cells is formed which occupies the roof of the encephalic vesicles from the posterior part of the middle-brain to the hind-brain. This mass in some cases reaches the spinal cord. The cells of this mass in part degenerate, the rest form a ganglion lying in the median line in the roof of the fourth ventricle. The cross-section of the myelencephalon of these embryos is larger, and the lumen of the fourth ventricle may be obliterated by the growth of this ganglion.

All these alterations seem to be the reverse of those produced by the action of lithium chloride, which causes an inhibition of the development of the notochord and of the prechordal plate and thus a hypoevocation, namely, cyclopia³. Experiments were made in order to determine what kind of substances are capable of producing cyclopia in embryos of the frog and axolotl. These were found to be substances which precipitate proteins. The stronger they are in Hofmeister's series, the more readily do they produce cyclopia⁴. Sodium thiocyanate and sodium iodide, which produce monsters with hyperdeveloped notochords and hyperevocation, inhibit protein precipitation. Sodium thiocyanate, which has the greater effect, is the more inhibitory according to Hofmeister's series. The vital dyes and parantrophol, which cause an increase in respiration, have the same action as the inhibitory substances. This shows itself in various phenomena of embryonic development. One can obtain 'animalization' of the

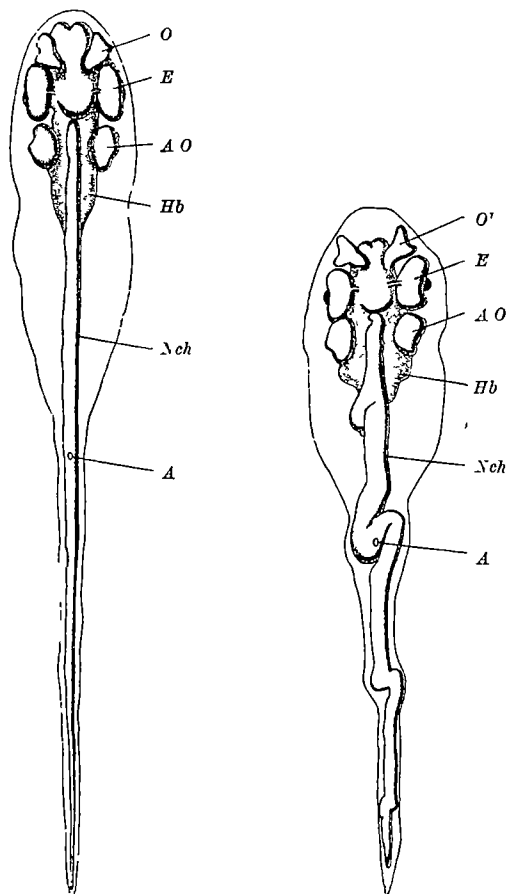


Fig 1

Fig 2

FIGS 1 AND 2. RECONSTRUCTIONS OF THE NOTOCHORD AND OF THE NERVOUS SYSTEM AS SEEN FROM THE VENTRAL SIDE. (1) OF THE CONTROL LARVA, (2) OF A LARVA WHICH AS A LATE BLASTULA WAS KEPT FOR 48 HR. IN 0.5 PER CENT SOLUTION OF NaSCN $2H_2O$. A, LEVEL OF THE ANUS, A O, OTOCYST, E, EYE-OUT, Hb, HIND-BRAIN, Nch, NOTOCHORD, OI, OLFACTORY ORGAN ($\times 17$).

embryos of echinoderms both with sodium thiocyanate and sodium iodide⁵ and also, though to lesser extent, with the vital dyes or parantrophol. Ventral explantations of young gastrulae of Amphibia show neural evocation, whether cultured in Holtfreter's liquid containing sodium thiocyanate⁶ or vital dye⁶. In these experiments sodium thiocyanate is more active than methylene-blue⁷.

The similarity of action of the vital dyes and sodium thiocyanate in these experiments is not yet clear.

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Jan 24

¹ Ranzi, S., and Tamini, E., *Naturwiss.*, 27, 566 (1939).

² Citterio, P., *Rend. R. Ist. Lombardo (Cl. Sci.)*, 75, 142 (1941); Bartolazzi, C., *Rend. R. Ist. Lombardo (Cl. Sci.)*, 75, 474 (1941); Ranzi, S., *Boll. Soc. Ital. Biol. Sper.*, 18, 314 (1943).

³ Lehmann, F. E., *Roux' Arch.*, 138, 106 (1938).

⁴ Tamini, E., *Roux' Arch.*, 142, 455 (1943).

⁵ Landahl, P. E., *Acta Zool.*, 17, 179 (1936).

⁶ Waterman, A. J., *Biol. Bull.*, 75, 376 (1938); Tamini, E., *Mon. Zool. Ital.*, 52, 81 (1941).

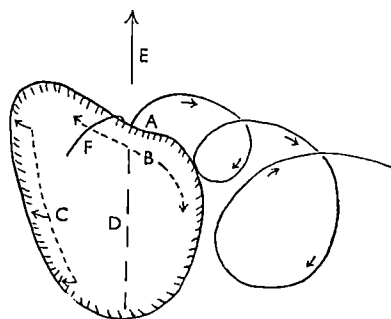
⁷ Ranzi, S., and Tamini, E., *Rend. R. Ist. Lombardo (Cl. Sci.)*, 75, 525 (1940).

⁸ Beatty, R. A., de Jong, S., and Ziellinski, M. A., *J. Exp. Biol.*, 1, 150 (1939).

Swimming of *Monas stigmatica*

RECENTLY it was discovered at Plymouth that *Monas stigmatica*, E. G. Pringsheim, which is a small gellate organism with a length of 6μ , was, under proper conditions, capable of traversing a length 260μ in a second. Thus the organism has a stative speed of more than forty, or in other words traverses forty times its own length in a second, and on this simple calculation the organism has a stative speed which is twice that of the most modern 'Spitfire' and a thousand times that of a modern destroyer.

The principle by which this high speed is attained is that of the rotating inclined plane or the propeller, and since these flagellate organisms represent what probably the most primitive of all free-swimming organisms it indicates that the principle of the rotating inclined plane or the propeller has existed on earth ever since living organism first existed near the surface of the ocean, which was probably two or three hundred million years ago. It was not, however, until the year 1842 that the Admiralty owned a battleship driven by a propeller.



Monas stigmatica WITH ITS TWO FLAGELLA. DIAGRAMMATIC

Waves pass along the long flagellum, from base to tip, in a spiral manner with an increase in velocity and amplitude. The force generated is transmitted to the surface of the cell at A. This causes the organism to rotate and gyrate about the axis D (the edge B going below the surface of the paper and C being raised above it). Thus the organism is converted into a rotating inclined plane and moves forward more or less in the direction indicated by arrow E. The very short flagellum F appears to act as a guiding or sensory organ during normal swimming.

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Porphyrim Formation by Yeast

In a recent communication, Rimington¹ has described his investigations into the formation of porphyrins by autolysing yeast and by yeast press, in which he demonstrated an increase in coproporphyrin in a cell-free medium prepared from yeast.

In our experiments we first of all attempted to determine conditions under which yeast would produce maximum amounts of porphyrin pigments. To this end, fresh top-fermentation brewer's yeast was allowed to autolyse at $19-22^{\circ}\text{C}$ alone and with the addition of various substances which were considered

possible porphyrin precursors. The best yield of porphyrin was obtained, however, by addition of solid ammonium carbonate to the yeast cells, when a yield of ninety-five times the value from yeast alone was obtained.

TABLE 1. COPROPORPHYRIN FORMED BY YEAST AFTER ADDITION OF AMMONIUM CARBONATE
450 gm fresh top-fermentation brewer's yeast. Duration of experiment, 96 hours

Experiment	Coproporphyrin found ($\mu\text{gm/gm}$ fresh yeast)
Yeast alone	0.9
With 10 gm $(\text{NH}_4)_2\text{CO}_3$	85.5
„ 10 gm $(\text{NH}_4)_2\text{CO}_3$ + 2 gm KH_2PO_4 + 2 gm NaH_2PO_4	59.0
„ 10 gm $(\text{NH}_4)_2\text{CO}_3$ + 30 ml amyl alcohol	43.8

When the rate of porphyrin production was studied under these conditions, it was observed that a rapid linear rise until approximately 60 hours was followed by a very sharp fall after 90 hours until porphyrin had almost disappeared from the medium. During the first period, the yeast cells were very active and the disappearance of porphyrin coincided with the onset of true autolysis of the cells.

TABLE 2. RATE OF COPROPORPHYRIN FORMATION BY YEAST AFTER ADDITION OF AMMONIUM CARBONATE
250 gm fresh yeast, 5 gm $(\text{NH}_4)_2\text{CO}_3$ added, kept at $19-22^{\circ}\text{C}$

Duration of experiment (hr)	Coproporphyrin found ($\mu\text{gm/gm}$ fresh yeast)	Relative amounts of isomers present ($\mu\text{gm/gm}$ yeast)		
		Copro III	Copro I	Copro III / Copro I
0	3.65			
6	13.2			
22	27.6	0.10	12.5	0.008
43	53.2	24.5	6.6	3.7
66.5	56.7	34.6	3.2	10.8
90.5	47.0	21.2	5.80	3.66
114	7.1			
162	3.2			
186	5.1	1.2	2.2	0.54
234	19.1			

The difference between the total coproporphyrin value and the sum of the two isomers is due to losses incurred in methylation and separation of the pure methyl esters.

When glucose, mannitol and other sugars were added to the yeast, it was observed that with prolonged activity of the yeast the porphyrin content also remained at a high level.

TABLE 3. COPROPORPHYRIN FORMATION BY YEAST AFTER ADDITION OF AMMONIUM CARBONATE AND SUGARS
250 gm fresh yeast + $(\text{NH}_4)_2\text{CO}_3$ + sugar

Experiment	Coproporphyrin found ($\mu\text{gm/gm}$ fresh yeast)			Relative amounts of isomers present after 168 hours ($\mu\text{gm/gm}$ fresh yeast)		
	24 hr	48 hr	168 hr	Copro III	Copro I	Copro III / Copro I
5 gm $(\text{NH}_4)_2\text{CO}_3$ + 5 gm glucose	16.8	24.0	60.0	0.0	33.2	0.0
5 gm $(\text{NH}_4)_2\text{CO}_3$ + 10 gm glucose	15.6	16.8	84.0	0.0	64.0	0.0
4.4 gm $(\text{NH}_4)_2\text{CO}_3$ + 25 gm glucose	16.8	5.7	84.0	9.4	46.0	0.2
5 gm $(\text{NH}_4)_2\text{CO}_3$ + 25 gm mannitol	9.3	18.7	100.8	1.5	67.2	0.02

Brewer's wort

284 (72 hr)

As a result of these and other experiments under varying conditions, it is concluded that the maximum formation of porphyrins by yeast is associated with great cellular activity, and the amounts here found are much greater than those resulting by changes occurring after death of the cells.

Intracellular poisons, such as sodium fluoride and even 1 per cent toluene, caused a rapid decline in the porphyrin content by slowing down the metabolism. Samples of brewer's wort collected at intervals during fermentation exhibited the same changes as with ammonium carbonate alone, with the accumulation of 284 μgm porphyrin per gram of original yeast at the end of the active fermentation period (72 hr), but all this pigment was used up in the ensuing forty-eight hours.

Fractionation of the porphyrins showed that traces only of proto- and deuterio-porphyrins were present, insufficient for identification of isomers. Coproporphyrin comprised in most instances a mixture of isomers I and III which were determined by ultra-violet fluorimetry and identified by crystallography and melting point of the methyl esters. The relative proportions of the two isomers varied within wide limits, it is interesting to see that coproporphyrin I predominates when sufficient carbohydrate for respiration is present, but in conditions of carbohydrate starvation (after 66 hours, Table 2) coproporphyrin III appears in large amounts, and is responsible for practically all the porphyrin present under these conditions. Thus the isomers III or I may predominate in yeast according to the nature of the nutrient medium.

Further investigations are being carried out to determine if, and how, these changes are related to cytochrome synthesis and rate of respiration.

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¹ Rimington, C., *Nature*, 151, 393 (1943)

Geology of the Punjab Salt Range

WITH reference to Sir Cyril Fox's interesting article under the above heading¹, I wish to make certain comments. I think that nobody maintains that the Kohat-Potwar Saline Series is of post-Eocene age. As Prof Sahni says², his "fossil evidence is consistent with any geological age from the Lower Tertiary to the recent. But since on stratigraphical grounds the Saline Series cannot be younger than early Tertiary, the conclusion is that it is of Eocene age." I have shown³ that the latest marine beds of that region are of Upper Khirthar (Auversian) age, so there were apparently no marine waters to desiccate, in that region, after the Eocene.

Again, aridity alone seems to be stressed when discussing the production of thick salt deposits. Thus Sir Cyril says (p. 259) that "an arid period almost certainly prevailed in early Cambrian or pre-Cambrian times, which, according to Mr Geo, was soon after the rock-salt deposits had formed in the Punjab area", and he adds that "there is little such evidence in support of an Eocene age for these deposits". But the main essentials for producing thick salt deposits are topographical rather than climatical. So far as climate is concerned, it is only necessary that evaporation should dispose of all

waters in, or entering, the area concerned, but the production of an excessive accumulation of salt is not a simple matter—it demands rare topographical conditions like, for example, those now existing in the Dead Sea region, or those on the eastern border of the Caspian Sea (Karaboghaz Gulf), etc.⁴ Nobody has yet attempted to show that the pre-Cambrian topography of the Kohat-Potwar region was of or of these exceptional kinds.

On the other hand, I have shown⁵ that topographical conditions of such a kind did apparently exist, in that region, in Lower Chharat (basal Khirthar, or earliest Middle Eocene) times. So I must point out that Dr West's summary of papers to which Sir Cyril refers (p. 258), is incomplete in this respect. For it was not until 1936 that I finished surveying the Eocene beds of the Kohat district, and realized that Lakki (Lower Eocene) elements did appear from below upwards to the west, and do not exist in Waziristan.⁷ French geologists, working from the opposite (Afghanistan) side, soon afterwards made corresponding observations⁸, showing that what I call a "Waziristan ridge" rose at the close of Ranikot (Palaeocene) times. The emergence of this ridge must have greatly reduced the marine connexions of the Kohat-Potwar basin, which were by more fully severed at the close of Lakki times.⁹ It is obvious that along the southern borders of the basin—and especially at their western extremity where spasmodic marine incursions still occurred even in Lower Chharat times¹⁰—topographical conditions would have favoured the production of large accumulations of salt (waters were, in fact, trapped and trapped in such a manner as to satisfy the theory of G. Bischof and C. Ochsennius regarding the way of forming thick salt deposits, cf F. W. Clark as above⁴). Thus I briefly indicated in my last letter the main point of which is apparently missed by those who refer to it¹¹ only to stress Mr Gee's change of mind as to whether the fossils which I identified in him had or had not, been found by him *in situ*.

To discuss further points would unduly extend this letter, so I merely emphasize, here, the need for considering the topographical essentials for producing thick salt deposits. Whether or not suitable conditions existed in pre-Cambrian times (a matter which seems never to have been worked out, and may not be capable of demonstration) I can scarcely agree that they did not exist in Eocene times. The Eocene is the one period when known structural evidence indicates that they did exist.

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March 19

¹ *Nature*, 155, 258 (1945)

² *Proc. Nat. Acad. Sci. Ind.*, 14, 86 (1944)

³ *Quart. J. Geol. Soc. Lond.*, 98, 199 (1940), 99, 63 (1943)

⁴ Cf. Clarke, F. W., "Data of Geochemistry", 216ff (1920)

⁵ *Nature*, 154, 53 (1944), etc.

⁶ *Curr. Sci.*, 3, No. 9 (March 1935)

⁷ Davies, L. M., *C. R. Soc. Géol. France*, 2, 22, 15, 294 (1938), *Nat.* 142, 296 (1938), etc. For diagram showing east-to-west success see *Quart. J. Geol. Soc. Lond.*, 99, 65 (1943), Fig. 1

⁸ Cizancourt, Mme. de, *Mém. Soc. Géol. France*, N.S., 17, Fasc. Mém., 59, 14 (1938)

⁹ See palaeogeographical diagrams, *Proc. Sixth Pac. Sci. Conf.* (1939), 3, 489, 494, etc. (1940). The delta of the proto-Kur river was shifted eastwards, as its contemporary deposits show by the emergence of this ridge, and may have further tended to be the marine connexion. Wind-rounded sand-grains (found by Dr R. M. Craig in collections from these deposits) indicate a local aridity than some suppose to have existed at that time.

¹⁰ Cox, L. R., *Ann. Mag. Nat. Hist.*, 11, 1, 172 (1938)

¹¹ *Nature*, 155, 267 (1945)

'Rubber Acid' Damage in Fire Hoses

READERS of the article on the above subject by Jansen, Bunker and Adams¹ may be interested in my experience when called upon to suggest means of preventing or delaying the relatively rapid deterioration of war-time fire hoses.

It was early realized that this deterioration was of bacterial origin and associated with the formation of sulphuric acid, although no attempt was made to isolate or identify the organisms concerned. On the strength of the information available, however, I decided to try the effect of sterilizing the hose after use. Calcium hypochlorite bleach liquor was therefore added to a static water tank so as to produce a residual free chlorine content of 5-10 p.p.m. (o-tolidine test). The contents of the tank were pumped through the hose (by means of a trailer pump) and back again to the tank. This circulation was continued for about 15 min., after which the free chlorine had fallen to 1 p.p.m. or less. The hose was then drained and stored.

There was no evidence of damage due to the chlorine. Comparative tests with lengths of similar hose which had been treated as described above, using chlorinated and unchlorinated water, showed that the life of the former was 50-100 per cent longer than that of the latter. The treatment had little or no beneficial effect on pre-war hose, which had a longer life in the untreated state. The treatment could, of course, be applied each time the hose is used, before it is stored.

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Nature, 155, 322 (1945)

A Colonial Scientific Service

I AM much interested in the idea of a Colonial biological service, as an independent organization or part of a wider Colonial scientific service, that my friend Mr K. H. Chapman has recently put forward¹.

What impressed me most often about the work of a scientific specialist serving overseas under the present system is the actual isolation in which his work is carried out, and the acute sense of this isolation which he often develops. One deleterious effect of this is that it may restrict research to problems for which facilities are available, and which may be relatively less important and perhaps not those for which the specialist's individual aptitudes are best fitted.

Many particular problems would be more rapidly solved if either additional specialist help could be made temporarily available, or the worker and his problem could be transferred to some laboratory or research institute in Great Britain. Some specialists manage to arrange the latter either by persuading their superiors to grant special leave of absence to work at home or by sacrificing part of their normal leave to the work. Admirable as the spirit of the latter solution is, it is wrong in principle, and the former may be dependent on sympathetic consideration by a non-specialist superior. Some of Mr Chapman's remarks are relevant to this last point.

A most important feature of a Colonial biological service with a centralized headquarters would be, as Mr Chapman points out, the possibility of concentrating selected specialists as a team on any specific problem and preventing overlap of unco-ordinated

individual efforts in different regions. An example of this kind of arrangement is the work of the Anti-Locust Centre in London², in connexion with which workers, scattered over a huge area, are all carrying out pieces of work in a pattern designed to solve the general problem of the locust pest. This particular project has drawn personnel from many sources not always immediately available in peace-time, but this only shows the resources which a centralized service might draw upon.

That biologists who intend to spend most of their active lives attached to research and teaching institutions in Britain would benefit from a temporary seconding to overseas work can scarcely be doubted. A centralized service would enable such secondings to be made in the most profitable way.

Another example is the work of the International Health Division of the Rockefeller Foundation. The Foundation's annual reports show how a cadre of experts has been moulded and remoulded to form the basis of a series of teams that have been sent all over the world to tackle problems in tropical medicine, especially those relating to insect-borne disease, a method yielding some quite spectacular results^{3,4}.

Whether a centralized service such as Mr Chapman has suggested would, as he seems to hope, equalize the inequalities of status that he has found between medical and veterinary practitioners and biological specialists is difficult to know. Surely the solution of this problem lies in the direction of making biology an organized profession. Chemists and physicists are moving in this direction with their respective institutes. If medical men, veterinarians, chemists, physicists, accountants, librarians and others can do this, surely it would not be beyond the wit of biologists to do likewise.

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¹ Chapman, K. H., *Nature*, 155, 146 (1945)

² Uvarov, B. P., *Nature*, 151, 41 (1943)

³ See Smart, J., *Nature*, 153, 765 (1944)

⁴ See Smart, J., *Nature*, 152, 279 (1943)

Wax Pencils for Writing on Cold Wet Glassware

THE wax pencils supplied commercially for writing on glass are unsatisfactory when the glass is cold, or covered with a film of moisture.

Pencils which will write on cold wet glass can, however, be prepared by the addition of 5-10 per cent of a detergent, preferably cationic, to the wax and pigment mixture forming the pencil 'lead'. Of the many possible formulæ, the following can readily be made up in the laboratory without special skill.

Hard paraffin wax (m.p. 65° C)	100 gm
Beeswax	20 "
'Vaseline'	20 "
C.T.A.B. (Cetyl trimethyl ammonium bromide)	10 "
Fat soluble dyestuff (for example, Sudan III)	0.5-1.0 "

The mixture is heated on a water bath and stirred until the waxes have melted and the dye and detergent dissolved. 20 gm of titanium oxide or other white pigment are then stirred in. The pencils are made by casting the mixture in sticks about 6 in long by $\frac{1}{8}$ in in diameter and wrapping in paper.

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SOCIETY OF AGRICULTURAL BACTERIOLOGISTS

ANNUAL MEETING

THE Society of Agricultural Bacteriologists held its fifteenth annual meeting at Leeds during December 17-19. The papers and the discussions covered a much wider field than is implied by the Society's title, a tendency which has become increasingly apparent each year since the Society adopted a policy of opening its membership to workers in all branches of bacteriology. Dr W. T. Astbury gave an address on the electron microscope followed by a demonstration of the instrument.

A contribution to the subject of disinfection dealt with the fundamental processes leading to the death of bacteria. In this work *Bacterium coli* was used as the test organism and phenol as the disinfectant. Special precautions were taken to avoid environmental changes during the tests, the phenol being added to cultures of the organisms grown in a special apparatus designed to ensure stable conditions throughout the period of the experiment. The experiments covered a range of phenol concentration from 3.48 to 8.0 gm/l., and a temperature range of 20-42° C. The results obtained led to the conclusion that the logarithmic curve of disinfection is really only an approximation, due to the process of disinfection proceeding too rapidly in the early stages to be estimated. The true disinfection curve indicated a slow initial death-rate, followed by a rapid rise to a high value, the peak value was followed by a rapid and then by a slower decline, the death-rate becoming constant at the extreme end of the process of disinfection.

Starr's aniline blue medium for the detection of lipolytic organisms has been improved by staining the butterfat substrate with Waxolene Red 111S (ICI), which ensures optimum colour differentiation between lipolytic and non-lipolytic colonies. Tests on forty-four cultures of lipolytic and non-lipolytic bacteria showed the new medium to be equal in discriminating powers to the copper soap method while possessing the added advantage that colonies could be subcultured following differentiation. It gave less false-positives than tributurum agar. Details of its preparation were given.

A study of methods suitable for assessing the sterility of equipment used in dairy and food manufacturing operations has shown the value of swab methods for this purpose. Colony counts on swab solutions from surfaces were normally much higher at 32° C than at either 37° C or 22° C, especially in the case of plant used for raw milk, meat canning, and in the bakery. The results emphasized the desirability of incubating plates at more than one temperature, and indicated 32° C to be the temperature of choice when only one incubator was available. The predominating flora of swab solutions from the various types of plant examined was described, and the value of the swab technique in tracing the source of specific fault-producing organisms in large equipment was emphasized.

Since the adoption of the methylene blue test as an official method for the examination of heat-treated milk, increasing interest has been taken in the use of dye-reduction tests for this purpose. The results of various bacteriological methods of testing pasteurized milk were related to keeping quality in a study of 505 samples of pasteurized milk distributed by

twenty-seven dairies during a period of two months. Neither the colony count at 37° C, the methylene blue test, nor the resazurin test were suitable measures of keeping quality when applied the day of distribution, but the dye-reduction test proved suitable for detecting milk with a poor keeping quality, when the samples before test were stored at 18° C from 3 p.m. on the day of distribution until 10 a.m. the next morning. The value of the coliform test for the examination of pasteurized milk was also once more confirmed. A simple lagged water bath, utilizing mains water cooling, with thermostatically controlled electric heating, was used for maintaining a temperature of $18 \pm 1^\circ \text{C}$.

The examination of raw milk by the resazurin test continues to receive attention as a means of grading milk. The suitability of this test as a measure of keeping quality was assessed by comparison with the methylene blue test, the colony count and the titratable acidity, the results being subjected to statistical analysis.

In an attempt to explain occasional discrepancies between the results obtained by the resazurin and other tests on raw milk samples, the effect of pre-cultures and of cells on the reduction of the dye has been investigated. Pure cultures of bacteria were found to vary markedly in their power to reduce both resazurin and methylene blue, although the more active milk-souring organisms reduced the dye faster than organisms not possessing this property. *Streptococcus agalactiae* and *Bacillus subtilis* were notable exceptions, the former being a poor reducer and the latter reducing resazurin at an appreciable rate. Methods of measuring the relative reducing activity of cells and bacteria were discussed, and the difficulties emphasized. Neither the enzyme inhibitors used nor the temperature effects tried provided a satisfactory solution to the problem.

Theoretical consideration has been given to the possibility of developing a more rapid and equitable method for testing large numbers of raw milk samples. Since souring is the predominating cause of defects and difficulties in handling, it was assumed that measurement of the increase in acidity under standard conditions of storage was most likely to offer a solution. Of the three methods available, titratable acidity was considered too cumbersome for routine purposes, and conductivity measurements, though technically relatively simple, were not considered sufficiently sensitive measure of increase in acidity. It was eventually decided to depend on pH value determined with a glass electrode. A close relationship was found to exist between decrease in pH value and increase in titratable acidity.

The cleansing and sterilization of milk bottles and other surfaces in which the strength of detergent governs the efficiency of the processes is a problem of immense commercial importance. Titratable methods are normally used for estimating and controlling the strength of detergents, but a method involving a direct-reading meter has obvious advantages. Preliminary work indicated the suitability of a direct-reading conductivity meter, and the construction of an apparatus suitable for use in detergent solutions in dairy equipment was described. Owing to variations in the constituents of commercial detergents, calibration of the instrument was found to be necessary for each detergent. The method had the further disadvantage that it was less sensitive to changes in the concentration of sodium hydroxide.

ian't it was to those of other salts, although it was pointed out that the majority of commercial detergents consist largely of carbonates and phosphates. An extensive survey, covering the period 1930-44, of the incidence of *Mycobacterium tuberculosis* and *Mycobacterium avium* in herd bulk milk from individual farms in mid- and west-Wales was reported. Some figures for school supplies of pasteurized milk, for milk creamery skim milk, both raw and pasteurized, and for udder samples from suspected cows were also included. Reasons were advanced for the very low incidence of tubercle infection (0.74 per cent for 155 samples) in farm supplies. No tubercle bacilli were found in any of the twenty-eight samples of pasteurized milk supplied to schools, nor in the forty-eight samples of pasteurized bulk creamery milk examined. Of the sixty-six samples of raw milk creamery skim milk, 6.06 per cent contained tubercle bacilli, legislation prohibiting the turn of raw by-products to farms was considered essential for the development of areas of tubercle-free herds. A much higher proportion (8.91 per cent) of raw milk samples was found to be infected with *Mycobacterium avium*, designated supplies showing a higher incidence than milk from undesignated farms. No positive results were obtained with the pasteurized samples.

In a paper dealing with the spoilage of marine fish, the sources and types of bacteria responsible were discussed. The existence in marine bacteria isolated from fish of an enzyme system, triamine-oxidase, which is not generally present in similar bacteria from other sources, was suggested as a basis for differentiating the various species of marine bacteria. Changes in flora which occurred during a 21-day period of storage on ice were also studied. Although aerobes were not considered to be as important as anaerobes in causing spoilage, the types isolated were described, and the isolation of a new serological type non-pathogenic tetanus bacillus, Type X, was recorded.

With the demand for canned foods for use by the Armed Forces in hot climates, new problems have had to be faced by the canning industry, since storage temperatures may be high enough to permit the germination and growth of spore-forming thermophilic organisms capable of causing spoilage. New methods of control have had to be introduced so as to reduce to a minimum the risk of infection before canning, as it is not always possible to increase the time or temperature of sterilization sufficiently to ensure destruction of the highly resistant thermophilic spores. Difficulty in sterilizing a mixture of meat and vegetable with a relatively high fat content was thought to be due to protection of the thermophiles by the fat. Cases of spoilage in canned vegetables are rare. Difficulty in canning potatoes late in the season was thought to be associated with the use of large tubers, which had to be cut before canning, the sterilization process being inadequate to kill spores at the centre when two cut surfaces came together again. In a paper dealing with the bacteriology of canned food, a novel method of canning was described. Difficulties in sterilization led to a proportion of spoiled cans. A gas-forming aerobic spore-former capable of utilizing nitrate as a source of oxygen, which was isolated from both spoiled and sound cans, was regarded as the causative agent, although other known factors were thought to play a part in the production of gas.

For several years, bacteriologists have necessarily

been concerned with the more pressing practical problems, but at this meeting a refreshing change was noticeable in that a few papers of a more fundamental character were included. A much happier blend resulted, which augurs well for the future of the Society.

Proceedings of the Society, containing full abstracts of the papers read, may be purchased from the Hon. Treasurer, Mr. L. J. Meanwell, United Dairies, Ltd., Ellesmere, Salop.

LONDON SCHOOL OF HYGIENE AND TROPICAL MEDICINE

IT was inevitable that the work of the London School of Hygiene and Tropical Medicine, which has exerted so profound an influence on the teaching and practice of tropical medicine by both British and other medical men, should have been radically affected by the War. The report of the School's work during 1943-44 shows how much its normal activities have been altered. Not only have thirty-six members of the staff been engaged on full-time war service, but also specific war problems have been studied at home, and the School has provided accommodation for members of the staff of the Medical Research Council and of the University of London, who are doing work of national importance. Nor have the School's buildings escaped war damage. Yet, during the year, it has been possible to give courses in tropical medicine to some five hundred Service medical officers and other special courses to 151 students. The acting dean, Prof. M. Greenwood, and the whole School are to be congratulated upon the year's work. It is gratifying to know that it has been possible to do, as well as war work, some fundamental research of a kind which is vital to the very existence of science, yet is, in the words of Prof. Greenwood, "slighted in wartime because the results may not be of immediate technological importance".

Prof. Greenwood refers to the difficulties which the School will have to face after the War, and he doubts whether national post-war needs will allow the School to resume normal teaching until, at the most optimistic estimate, the autumn of 1945-46, perhaps not until a year later. He suggests that the resumption of teaching will not be easy, for the returning staff will have lost touch with the normal problems of academic work and will have to teach a generation trained somewhat hurriedly and under difficulties.

The brief departmental reports indicate the effects of departures of staff for war work and also of the national value of the work which has been accomplished in spite of these losses. Thus the Department of Entomology has been much concerned with work on DDT, which was originally brought to the School by a representative of the Swiss firm which placed this remarkable insecticide at the disposal of the British and American Governments (see *Nature*, Nov. 11, 1944; p. 600). Methods of impregnating clothing with DDT for the control of human lice were devised, and this method of applying DDT is now general. The use of DDT for the control of the bedbug is also being studied. Much work has been done on fumigants and mosquito sprays, and a formula for the latter containing DDT has been generally adopted. The physical and chemical problems involved in the control of insects by means of sprays are also being investigated. This Depart-

ment has lost the services of Dr V B Wigglesworth, who has been appointed director of the Insect Physiology Unit of the Agricultural Research Council, but co-operation between these two departments continues. Dr Wigglesworth has studied the part played by waxes in maintaining the impermeability of the insect cuticle to water and has found that some chemically inert dusts abrade the wax and thus kill insects by causing them to dry up (see *Nature*, 153, 493, 154, 333 (1944)). His Unit is also studying the action of insecticides used as sheep dips against the sheep tick, *Ixodes ricinus*, the water relations of this tick and the physiology of the sheep blowfly, *Lucilia sericata*. Field trials of DDT as a sheep dip are also being made. The possible importance of work of this kind to all those who are concerned with world supplies of meat, wool and other animal products can scarcely be over-estimated.

The head of the Department of Biochemistry, Prof H Raistrick, has given much time to work with penicillin; he is honorary scientific adviser to the Ministry of Supply on penicillin production. This Department has also studied the deterioration of service equipment in the tropics due to the action of moulds and is searching for antibiotic substances of microbiological origin. Although *penicillium patulum*, prepared by the Department from *Penicillium patulum*, proved unable to control the common cold (see *Nature*, 154, 807, Dec 30, 1944), two other metabolic products of this mould have been isolated, namely, gentisic acid and the hitherto unknown gentisyl alcohol, the latter has been synthesized. A new antibacterial substance has been isolated from cultures of "a somewhat rare mould" which has not yet been identified with certainty, this substance appears to belong to a new type of organic compounds and its properties are being studied. Diplococcin, a new antibacterial substance formed by some strains of milk streptococci, has been isolated. It is probably, the report says, identical with a substance independently isolated at the National Dairy Research Institute, Shinfield, and described by A T R Mattick and A Hirsch (*Nature*, 154, 551, Oct 28, 1944). Mattick and Hirsch found that the substance isolated by them protects mice against strains of haemolytic streptococci virulent to mice and suggest that it may be useful for the treatment of bovine mastitis.

The appointment of Prof J M Macintosh to the University of London chair of public health assures the School of vigorous and able leadership. The Association of Industrial Medical Officers is using the School more and more as its headquarters. Among researches done at the School's Department of Industrial Physiology are those on the insulating properties of clothing materials, the important question of portable sources of light, such as reading lamps, the results of which study have been published in the *Transactions of the Illuminating Engineering Society*, and the dangers to health of industrial dusts, advice given on the working conditions in factories has brought benefit to many workers.

The Library of the School has been busier than ever. It has increased its stock of books and pamphlets, but has experienced the difficulty of obtaining American books which is the subject of an Annotation in the *Lancet* (217, Feb 17, 1945). The School also houses the Bureau of Hygiene and Tropical Diseases, the painstaking and indefatigable work of which, published in the pages of the *Tropical Diseases Bulletin*, the *Bulletin of Hygiene* and the *Bulletin of War Medicine*, makes available abstracts of the

medical literature of every country in the world. These abstracts are done by a panel of experts, whose experience adds a critical quality which is absent from many other publications of this kind.

The Institute of Agricultural Parasitology, directed by Prof R T Leiper, professor of helminthology at the School, has done much work at Winches Farm, St Albans, on the nematode parasites of valuable crops. A catalogue of more than six hundred species of helminths parasitic in birds of economic importance has also been compiled. A method has been devised for the identification of certain nematode species from the females alone, which should be of great value to parasitologists, and the nature and development of cestode hooks has been studied. It is at Winches Farm also that the work of that other valuable source of information, the Imperial Bureau of Agricultural Parasitology, is done.

Everyone will wish the School a speedy return to its normal activities when the completion of its work makes this possible.

RACIAL PROBLEMS IN AUSTRALIA

WITH the progress of civilization and the continued penetration by the white man into the domain of the coloured peoples, there comes the problem, ever increasing in intensity, of the contact and clash of conflicting customs. Men in the stone or iron age are caught up into the complicated machinery of the Western world, and the results are necessarily difficult to regulate and often disastrous to the simpler peoples.

The Anthropological Society of South Australia at its meeting in May 1944 held a conference arranged by the South Australian Division of the Australasian Association of Scientific Workers, during which there was a discussion on racial problems to which Prof J B Cleland contributed a valuable address. He pointed out that the Australian aborigines, contrary to popular belief, present a high order of intelligence and had they not settled in a country which provided very few amenities, they would probably by now have reached a much higher stage of civilization. "What could they do in a country boasting no animal life higher than the marsupial and practically cultivable plants? They were forced to remain nomads and with the arid conditions so frequent obtaining could make no permanent habitations."

Potentially, however, judging by a complex language and by the attainments of certain individuals, the Australian aborigine has a mental make-up appreciably below that of the white man, though he has specialized in a different direction. There is nothing to show that crosses between them and good class whites are likely to produce undesirable hybrid breeds, the fact that many half-castes are inferior being probably due to the low-class and often vicious white men of whom they are the offspring.

There have always been attempts to guide the aborigines into European ways, but these have heretofore led to rapid decline and death, owing in great part to lack of interest in living when removed from their native mode of life with its frequent ceremonies. It seems, in fact, impossible for the full-blooded natives to maintain themselves in a white community, and the only hope for them is to make the few places to which they can call their own as inaccessible as possible to the white man. There will naturally always be certain

venturous spirits who will roam away and, through contact with the whites, lose touch with the old. These newly detribalized men should be assisted to maintain themselves as respectable members of a community and to do suitable work, as much in a country as possible, on the cattle and sheep stations. They should be under some sort of supervision and be encouraged to keep up their tribal customs and corroborations.

The completely detribalized aborigines of long-standing separation from their own communities are more difficult problem, having mostly become banized and of mixed blood. Prof Cleland considers that they should not be segregated from the whites and regarded as inferiors, but should be educated to become good citizens and take their share of community life.

K RISHBETH

PREHISTORY IN THE CONGO*

THE prehistoric archaeology of the Congo is very little known. The researches of Dr Cabu were first published at the International Congress held in Brussels in 1935, but most of his discoveries are still unknown to the average prehistorian. Yet the Congo is probably a key area, linking as it does the north with the south of the African continent. The little bit of information on the subject which had come current among prehistorians concerned an alleged new culture, the Tumbrian, but now even this latter seems actually to be non-existent, and the history in question merely a *mélange* of early, middle and later stone age material, somewhat responding to the Sangoan of Uganda.

It is, therefore, of very great interest to have the studies as these under notice from the pens of prehistorians of the eminence of Profs Breuil and Riet Lowe. Alas, there are no illustrations. Both authors' articles are technical, and describe in detail the industries found at a number of stone age sites and their cultural affinities. An intriguing reference occurs at the end to discoveries of painted rock-shelter sites. The paintings are in red and conventionalized. Prof. van Riet Lowe also describes in detail the industries and compares them with those occurring in South Africa and in the Uganda-Kenya regions. He, too, claims that the Tumbrian consists of "advanced Acheul, La Micoque and Combe auenne bifaced tools (i.e., Fouresmith), ? proto-Stillbay, Sangoan picks, Stillbay points, Aterian and African bifaced points (including pedunculate ones), ground and polished axes and pottery", "a mixture". He also notes the occurrence of lithic tools. This reinforces the contention that this culture is not purely a South African product, but backs up Archdeacon Owen's finds of a Smithfield industry in western Kenya.

Quite obviously we shall have to await the end of the War for a full account of the prehistory of the Congo. But enough is here given to make it clear that this important area is likely to be critical in any general appreciation of the Stone Ages in Africa.

M C BURKITT

"Le Paléolithique du Congo Belge d'après les recherches de Dr Cabu". By l'Abbé Henri Breuil. Les industries paléolithiques de la terrasse de 15 Mètres et d'un al secondaire comble, Plaine de Fiemont de Leopoldville, d'après les fouilles et photographes du Docteur Cabu". By l'Abbé Henri Breuil. Notes on Dr Francis Cabu's Collection of Stone Implements from Belgian Congo". By Dr C. van Riet Lowe. Printed from *Trans Roy Soc S Africa*, 30, Pt 2 (1944).

STRAY LOSSES IN SYNCHRONOUS ELECTRICAL MACHINERY

P. RICHARDSON, in a paper read before the Institution of Electrical Engineers in London recently, discusses the problem of eddy currents from the point of view of the effect of the physical arrangement of an alternator on the stray losses, and deals afterwards with the components of stray loss. Since the latter can be classified conveniently in accordance with their position in the alternator, the stray losses which occur in the stator are considered first.

It is shown how the arrangement of the end-windings influences the shape of the end leakage field and thus the intensity of loss in the adjacent metallic structures, and how the loss in the core-end-plate can be estimated. The effect of magnetic and non-magnetic shielding arrangements is discussed, together with details of their arrangement. Experiments in connexion with eddy-current losses in the stator end connexions are described. Consideration is given to the iron loss which occurs in the stator core under steady three-phase short-circuit conditions owing to the flux-wave shape, and the indications are that this provides at least a partial explanation of why the stray losses can be so appreciably greater on short-circuit than on load.

The stray losses in the rotor, generally grouped under the heading of rotor surface losses, are shown to be due to several effects, notably to the concentration of ampere-conductors in one slot and to the irregularities present in the stator magnetomotive force wave. Consideration is also given to the surface or pole-face losses resulting from the 'tufting' of flux under the stator teeth, which loss is experienced under conditions of no load and is normally measured with the stator iron loss. The factors affecting the surface losses are discussed, together with methods for reducing the losses to a minimum. An indication is given of the relationship between the stray losses at the ends and those located within the core-length of an alternator, together with a description of the effect of load conditions on each of the components of stray loss.

FORTHCOMING EVENTS

Saturday, May 12

INSTITUTION OF THE RUBBER INDUSTRY (MIDLAND SECTION) (at the Imperial Hotel, Birmingham), at 10 a.m. and 2 p.m.—Symposium on "The Physical and Chemical Breakdown of Rubber"

Monday, May 14

ASSOCIATION OF AUSTRIAN ENGINEERS, CHEMISTS AND SCIENTIFIC WORKERS IN GREAT BRITAIN (joint meeting with the ROYAL NETHERLAND INSTITUTE OF CIVIL ENGINEERS AND THE SOCIETY OF DANISH CIVIL ENGINEERS) (at the Institution of Structural Engineers, 11, Upper Belgrave Street, London, S.W.1), at 6.30 p.m.—Prof. K. W. Mautner "Extension Work on the Harbour of Dunkirk, 1930-1938" (Lantern Lecture)

Tuesday, May 15

ROYAL SOCIETY OF ARTS (DOMINIONS AND COLONIES SECTION) (joint meeting with the ROYAL AFRICAN SOCIETY) (at John Adam Street, Adelphi, London, W.C.2), at 1.45 p.m.—Mr Malcolm Guthrie "East Africa's Reactions to European Culture"

INSTITUTION OF ELECTRICAL ENGINEERS (RADIO SECTION) (at Savoy Place, Victoria Embankment, London, W.C.2), at 5.30 p.m.—Discussion on "The Characteristics of Luminescent Materials for Cathode Ray Tubes" (to be opened by Mr C. G. A. Hill)

Wednesday, May 16

ROYAL SOCIETY OF ARTS (at John Adam Street, Adelphi, London, W.C.2), at 1.45 p.m.—Prof. J. D. Bernal, F.R.S. "The Social Relations of Science" (Trueman Wood Lecture)

GEOLOGICAL SOCIETY OF LONDON (at Burlington House, Piccadilly, London, W.1), at 3 p.m.—Scientific Papers

Thursday, May 17

ROYAL SOCIETY OF ARTS (INDIA AND BURMA SECTION) (at John Adam Street, Adelphi, London, W C2), at 2.30 p.m.—Mr F H Andrews "An Oriental Cultural Centre in London"

LONDON MATHEMATICAL SOCIETY (Royal Astronomical Society's Rooms, Burlington House, London, W 1), at 3 p.m.—Dr K Mahler "Lattice Points in n -Dimensional Star Bodies"

CHEMICAL SOCIETY (at the Royal Institution, Albemarle Street, London, W 1), at 5 p.m.—Prof J D Bernal, F.R.S. "The Past and Future of Crystal Chemistry" (Hugo Muller Lecture)

BRITISH INSTITUTION OF RADIO ENGINEERS (LONDON SECTION) (at the Institution of Structural Engineers, 11 Upper Belgrave Street, London, S W 1), at 6 p.m.—F Jones and R Sear "The Measurement of Cable Characteristics at Ultra-High Frequencies"

Friday, May 18

ROYAL INSTITUTION (at 21 Albemarle Street, London, W 1), at 5 p.m.—Prof H D Kay, F.R.S. "The Secretion of Milk"

INSTITUTION OF ELECTRICAL ENGINEERS (MEASUREMENTS SECTION) (at Savoy Place, Victoria Embankment, London, W C2), at 5.30 p.m.—Sir Lawrence Bragg, F.R.S. "Magnetic Materials"

APPOINTMENTS VACANT

FUEL TECHNOLOGIST for steelworks in north-west England—Ministry of Labour and National Service, Central (T and S) Register, Room 5/17, Sardinia House, London, W C2, quoting F 2230 A (May 15)

RESEARCH ASSISTANT IN INDUSTRIAL OPHTHALMOLOGY at the Institute of Ophthalmology, Royal Eye Hospital, London, S E 1—The Secretary (May 15)

ENTOMOLOGIST in the Research Division, Department of Agriculture and Forests, Sudan Government—Ministry of Labour and National Service, Central (T and S) Register, Room 5/17, Sardinia Street, London, W C2, quoting F 3969 A (May 16)

TEMPORARY SENIOR TECHNICAL OFFICERS (Ref C 2578 A) and TECHNICAL OFFICERS (Ref C 2579 A) in the Ministry of Aircraft Production for the development of civil transport aircraft—Ministry of Labour and National Service, Central (T and S) Register, Room 5/17, Sardinia Street, London, W C2, quoting appropriate reference number (May 16)

DIRECTOR (female) at the Middlesex Hospital, London, W 1—The Secretary-Superintendent (May 19)

CHIEF CHEMIST AND METALLURGIST, for works in north-east England, preferably with experience of the aluminium industry—Ministry of Labour and National Service, Central (T and S) Register, Room 5/17, Sardinia Street, London, W C2 (quoting F 3905 XA) (May 22)

TECHNICAL DIRECTOR OF A FOOD ORGANIZATION—Ministry of Labour and National Service, Central (T and S) Register, Room 5/17, Sardinia Street, London, W C2 (quoting Ref F 3831 XA) (May 26)

PROFESSOR OF MATHEMATICS at the University College of North Wales, Bangor—Acting Registrar (May 31)

ABSTRACTORS FOR RADIO AND ALLIED SUBJECTS at the National Physical Laboratory—Ministry of Labour and National Service, Appointments Dept (A 3), Sardinia Street, London, W C2 (quoting Ref P N 122)

SECRETARY to the University of Edinburgh—The Secretary

REPORTS and other PUBLICATIONS

(not included in the monthly Books Supplement)

Great Britain and Ireland

Transactions of the Royal Society of Edinburgh Vol 61, Part 2: No 12. The Blind Seed Disease of Rye-Grass and its Causal Fungus. By Dr Malcolm Wilson, Dr Mary Noble and Dr Elizabeth G Gray. Pp 327-340+1 plate. 4s. Vol 61, Part 2, No 14. The Kalsite-bearing Lavas of Kabarege and Lyakauli, South-West Uganda. Part 1, by A D Combe, Part 2, by Dr Arthur Holmes. Pp 359-379+1 plate. 6s. (Edinburgh and London Oliver and Boyd, 1945) [194]

Imperial Forestry Bureau Technical Communication No 2. Co-operation in Forestry. By Dr I Kissin. Pp 72. 4s. Technical Communication No 3. Forestry Credit. By Dr I Kissin. Pp 28. 2s. 6d. (Imperial Forestry Bureau, 1944-1945) [194]

South-West Essex Technical College and School of Art Annual Report, Session 1943-44. Pp 32+4 plates. (London South-West Essex Technical College and School of Art, Walthamstow, 1945) [174]

Royal Aircraft Establishment Education and Training. Pp iv+28+12 plates. (Farnborough Royal Aircraft Establishment, 1945) [174]

Ministry of Education Memorandum on the Building Regulations. Being the Regulations dated March 24, 1945, prescribing Standards for School Premises, made under Section 10 of the Education Act, 1944. (S.E. and O 1945, No 346) Pp 25. (London H.M. Stationery Office, 1945) 6d. net [174]

British Industry and Commerce its History and Reconstruction. Pp 66. (Sheffield Central Library, 1945) 6d. [174]

The Future of University and Higher Education. A Report prepared by the National Union of Students of the Universities and Colleges of England and Wales. Pp 16. (London National Union of Students, 1945) [174]

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NATURE

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RELIEF AND REHABILITATION IN EUROPE

A MAJOR problem now before the United Nations is the provision of food, clothing, medical supplies and other necessities of life in the newly liberated countries of Europe, so that they may be able to carry on until long-range plans for rehabilitation begin to take effect. The debate in the House of Commons on March 28 on supplies for Europe fairly reflected the growing concern which has been, and still is, felt in Great Britain. The seriousness of this question of relief and rehabilitation as a reconstruction measure has repeatedly been emphasized, in such books as Mr Bryant's "Unfinished Victory" even five years ago, in Colonel Bonsal's recently published diary of the peace conference following the War of 1914-18 entitled "Unfinished Business", and in such scientific studies as those of the Royal Institute of International Affairs on "Medical Relief in Europe" and "Relief and Reconstruction in Europe the First Steps". The picture of Berlin and the mind of Germany as they impressed Colonel Bonsal in the early part of 1920 are full of significance in regard to the probable position of Europe in the months immediately ahead.

The speech of Earl Winterton in opening the debate in the House of Commons shows clearly, however, that scientific workers have a special responsibility in this field to enable effective action to be taken. It is not disputed that the economic condition of the Western countries in Europe which have been subjected to the German occupation is serious. Nor can it be disputed that the position means much present human suffering and future political danger. It is clear also that a great responsibility rests upon Great Britain and the United States in the matter, since we command practically all external air and sea transport and, for military reasons, most of the internal transport. The figures quoted by Lord Winterton were not disputed by the Lord President of the Council in his reply, though Mr. Attlee insisted that there has been no discrimination against France, as Lord Winterton implied, and that France has shared in the general pool of shipping. Broadly, we are trying to get supplies from where they are to where they are needed, and at the same time to ensure the greatest economy in shipping, haulage and port facilities.

Mr Attlee's sober statement was somewhat reassuring, and in particular his announcement that the Ministry of Food was releasing to the liberated areas, which includes some of the Mediterranean areas as well, 900,000 tons of food from British stocks, and that the Ministers of Production and Food had gone to the United States at the invitation of the President to discuss the special food problems of the liberated areas. Mr Attlee's speech, furthermore, put the proposals with regard to 'food parcels' in their proper context, and his emphasis on the position of Britain as a food-importing country was phrased so as to avoid alike any possibility of international misunderstanding or recrimination, or doubt

as to the Government's realization that it is vital to get as good conditions as we possibly can in the liberated areas, as soon as we can. That, he agreed, is as essential for winning the victory of freedom and democracy as destroying the enemy in the field.

Mr. Attlee's statement should also help to make the position of the United Nations Relief and Rehabilitation Administration in this matter clearer, in this he was supported by Sir Arthur Salter, who pointed out that the activities of the Administration have always been subject to military considerations. Lord Winterton's fourth contention, however, was that the question for decision was whether we and the United States had taken sufficient remedial measures, having regard not merely to the supreme military needs of the moment but also to the fact that hungry people are not discriminating, and that France, Belgium and Holland are democratic countries *par excellence*. If the ordinary people there think that Britain and the United States have mishandled the food situation for military reasons, the war of liberation will cease to be as popular as it should and the liberating powers will not receive the gratitude they deserve.

This point was really met by Sir Edward Grigg in winding up the debate, when he said that in considering measures of military relief, the agreed policy of the United Nations is, and must be, to encourage the liberated peoples to assume responsibility for their own affairs as soon as possible. That is a definite instruction to all civil affairs officers who go into liberated territories. This assurance is welcome, as any other policy would involve the responsibility for future misery in Europe being saddled on Britain instead of firmly and primarily on Germany and the Axis Powers, and secondly on the local authorities responsible for local shortcomings.

Sir Edward Grigg's speech, while claiming that the military authorities, within their limited functions in the matter, have done and will continue to do their utmost to prevent disease and unrest in the immediate wake of the armies, never concealed that we are faced with a problem the gravity of which it is impossible to over-estimate, and neither his speech nor the trend of the debate as a whole left any room for complacency. A sense of urgency permeated the debate, and the suggestion advanced by Sir Arthur Salter that we should establish without delay an authority such as a supreme reconstruction council, comparable with the Supreme Economic Council established in 1919, was welcomed by one speaker after another before Sir Edward Grigg promised that the Government would take note of the matter.

Sir Arthur Salter's suggestion was for an authority which would co-ordinate for the principal victorious powers all their policy and efforts in assisting the reconstruction of Europe. He does not regard it as work for the Social and Economic Council of the Dumbarton Oaks proposals, or any organization set up as a result of the San Francisco Conference. He believes it is essentially a part of the peace settlement itself and should be established quickly, if

we thus supplement our present system, we have good hope of meeting the greatest challenge the constructive effort of men that has been witnessed in the history of the world, without it our present system will be completely inadequate.

There was, in fact, not only a large measure of agreement on this proposal running through the debate, but also on other aspects of the situation, the debate should have done something to educate public opinion still further as to the urgency of the situation, and to bring people to realize how serious is the problem and how grave is the prospect for European civilization if we do not take the necessary action now. The enlightenment of public opinion is an indispensable condition of success, in Great Britain as in other countries, for only so can we be sure that adequate support will be forthcoming for measures demanded, and that the personal sacrifices involved in the continuance of rationing and other necessary controls will be cheerfully accepted. At all, it is only the force of public opinion which can deal effectively with 'black marketing' and other disorders which endanger morale. Mere organization, however superlative, will never win the peace or establish a world order out of the chaos into which it is now clear that the Nazis have been deliberately seeking to engulf the whole of Europe.

In that task of education, however, scientists and workers have a special part to play, parallel to that which they played in regard to nutrition in Great Britain, and which, as Lord Woolton has justly said, did so much to secure the acceptance of a food policy which averted disaster. Dr. Haden Guest rightly pointed out that the United Nations Relief and Rehabilitation Administration has in fact done a great deal of valuable work in surveying the resources of food and materials and, if used as the Civil Service of a supreme economic authority, could do more still. The chairman of the combined food organizations has said that with the co-operation of Governments, the overall needs of Europe might be supplied, not indeed by moving rapidly to a full diet, but by providing a normal caloric grammage of rations. Certain items such as meat and fats admittedly are likely to be scarce for five or ten years or more, and Mr. Attlee referred to the danger of world shortages in fats and milk products particularly.

What is required, however, is to translate these terms understood by everyone, the meaning of the differences between the accepted standards of an adequate diet based on scientific investigation, such as the agreed minimum daily ration of 2,800 calories and those actually received in France, Italy, Holland or elsewhere, and the cumulative effect of the periods of starvation or semi-starvation deliberately imposed for four or even five years by Germany on the people of occupied Europe. The physical, mental and psychological consequences—the lowering not merely of physical vitality but also of powers of moderation and judgment through loss of vitamins and malnutrition—are matters of scientific fact which men of science are well qualified to interpret to their fellow citizens.

and it is one of their first duties to show convincingly why and how this policy of relief and food and medical supplies is both a humanitarian issue and a matter of the fundamental interests of the United States and Britain. They of all men and women should not need the words of Lord Templewood to remind them that unless we make a swift and united effort, the Nazis, although broken in the military field, may win in the civil by the victory of destruction. It is not, however, the question of food supplies alone, though that is important. As Dr. Eaden Guest and Mr. Greenwood reminded us, we have escaped epidemics so far, but the circumstances in which epidemics grow are being spread all over Europe at the present time. Prevention is very urgent indeed, and the displaced populations to which reference was freely made in the debate, whether refugees, prisoners of war or those forcibly deported, only accentuate the difficulties and dangers even in Great Britain we do not stand outside the range of large-scale epidemics if they start in Europe.

On this count also, Dr. Guest believes that some further inter-government staff organization is required. Besides this, however, there is the question of getting European agriculture and husbandry started again, as was emphasized by Mr. Greenwood and Sir James Gigg. Food and clothing are not the only necessities. Fertilizers, seeds and agricultural implements will also be required, apart altogether from the question of raw materials to get the factories in Europe started again, though industrial reconstruction is part also of this question of quickening European life. Even from the point of view of food supply, the reconstruction of European agriculture is an urgent task, the successful performance of which implies all the difference between peace and the return of individuals and nations to peaceful life. How important is this task and how great are the difficulties are well shown in an article

Prof. K. Brandt of the Food Research Institute, Stanford University, California, in a recent number of *Foreign Affairs*, which states that while such reconstruction must be the responsibility of national governments, economic policy should be worked out in international agreement. The major part of the work, however, lies outside agriculture, and Prof. Brandt points out that the recovery of European agriculture depends on the prior recovery of industry in Great Britain and all the Continental countries, and on the volume of post-war international trade, and primarily on decisions taken by the United States, the world's leading industrial power and the greatest creditor among the nations.

Prof. Brandt's article deserves attention, for the urgent problem of relief cannot be separated entirely from the long-term problem of reconstruction. The question was not always made clear in the House of Commons debate, except perhaps in so far as the fact that Great Britain is herself a food-importing country was rightly stressed. It is essential that the limitations should be as clearly understood as the implications of the continuance of undernourishment and starvation in Europe. It may well be

that such a gesture as food parcels may be administratively impracticable or inefficient. It may even be that on the examination which Sir James Gigg promised, Mr. A. P. Herbert's proposal for the assembly and organization of small craft to take food and supplies to the Continent as they once brought back the British army may prove impracticable, though for psychological reasons neither gesture of sympathy, apart from its practical service, should be lightly dismissed. If such proposals are rejected, however, the reasons must be clearly and fully explained, for the widespread public concern to which the debate testified cannot be disregarded. Moreover, if it is important that scientific workers should continue their task of interpreting the findings of the science of nutrition in terms of an adequate diet and a reasonable food policy not only for Britain but also for other countries, and that their attention to agricultural research should be sustained by a high sense of social service, it is equally important that the full facts of the world situation should be fully understood by the general public.

The people of Britain must be brought to recognize the limitations as well as the possibilities of action by their Government alone or in co-operation with those of other countries. The same generous spirit which inspired the idea of food parcels will effectively support the Government in whatever action may be required, and accept with patience and fortitude not merely the continuance of our present ration-scales which, as Sir Edmund Gigg said, are not large, but also, now that the fighting itself has come to an end, whatever further controls may be required to implement the chosen policy. To avoid reaction against such controls and rationing, and the all-important effort of food production on allotments, for example, their purpose must be made plain to all. Their relation must be demonstrated to the larger tasks of defeating the deliberate attempt which Germany has made to render civilization and an ordered life impossible in Europe, and establishing a world order from which disease and want and squalor have been banished, so far as lies within man's power.

SIX DECADES OF AMERICAN BOTANY

John Merle Coulter

Missionary in Science. By Andrew Denny Rodgers, III. Pp. x+321+2 plates. (Princeton, N.J.: Princeton University Press, London: Oxford University Press, 1944.) 25s. net.

THE history of botanical science in the United States is being duly surveyed and conserved. Already from the Princeton University Press there has come an account of the work of John Torrey, a volume on American botany from 1873 until 1892 is promised in the near future, now there is available a considerable work on John Merle Coulter. The method of presentation is biographical, but the work is really as much the history of a period as an account of the life and work of an individual. It is well that such studies should be undertaken before the essential

documentary materials are lost or begin the inevitable drift into obscurity

John Merle Coulter (1851-1928), who was to become a leading figure in American botany, graduated from Hanover College, Indiana, in 1870 and almost immediately began the active life of teaching and research that was to extend well into the present century. It may be profitable to pause for a moment and consider broadly some of the more evident antecedent and contemporary developments in biology, and of botany in particular, in Europe. Hofmeister's "Higher Cryptogamia" and "Allgemeine Morphologie" and the studies of Naegeli, Von Mohl and their contemporaries were available to botanists interested in the life-history, anatomy and morphology of many classes of plants. Darwin's "Origin of Species" had been published, Huxley's incisive views on the relation of the new scientific developments to contemporary theological views were already well known, while Hooker had shown what could be made of the systematic and geographical study of the flora of regions hitherto untouched. The great and progressive German schools of botany were in the ascendant and yearly were attracting more and more of the younger British botanists who had failed to find the guidance and inspiration they had sought in their own universities.

And now to return to the American scene. The education given at Hanover College—a Presbyterian foundation—was essentially classical, and not until 1874 was the teaching of science nominally put on an equal footing. Coulter's introduction to botany was through the medium of excursions. It is perhaps scarcely surprising that his initial interest, which he retained throughout his life, was in taxonomy. On all sides, in a vast territory where the recent decline in Indian warfare was making scientific expeditions possible, there was immediate work to be done in collecting, naming and classifying plants and in relating them to their highly diverse environments. Thus in 1872 we find young Coulter and other members of the Yellowstone Geological Expedition for-gathering in the Mormon town of Ogden. We are given a vivid picture of how their eyes opened wide as they walked through the town reading the signs above the Mormon stores "Holiness to the Lord," "Zion's Cooperative Mercantile Institution." Coulter set out on the expedition to assist in the geological survey, but, because of his spontaneous interest in plants and his zeal for collecting them, he returned with the official title of botanist. Thereafter, by steps that need not be described in detail, he became professor of natural science at Hanover, then at Wabash College, Indiana.

His essential contributions to botany in this initial phase were two-fold: first, like many of his contemporaries, he contributed to the production of regional floras, for example, his "Catalogue of Indiana Plants" (1881) produced in collaboration with his brother and Barnes, and secondly, he founded the *Botanical Gazette* in 1875. At that time he was probably a typical product of the prevailing Presbyterian background and, as the author informs us, to him "Science was the instrument of theology." Although a professed biologist, the theory of evolution was apparently not one which had stirred him deeply. But in 1879 and 1880, a new phase began. By attending the summer courses given at Harvard University under Prof. Asa Gray, the leading figure in American botany, and by coming into contact with such men as Farlow and Goodale, both of whom

had studied in the great European laboratories, he began to realize something of the potential scope of his science. The new studies included morphology, anatomy and physiology. It was made clear to him that observation, the basic method of science, must be amplified by experimentation. At that time probably not more than half a dozen botanical laboratories in the United States had other than taxonomic facilities for study, a situation very like that obtain in British universities. The publication of Bessey's "Botany" (1880), containing sections on anatomy and physiology, was a landmark. It apparently opened for American botany what the publication of Sauer's "Lehrbuch" in English (1775) did for British botany. At this point there occurs one of the most fascinating sketches in the book. It was probably typical of the beginnings of many New World institutions: concerns the young botanist Bessey, who, three months after graduation at Michigan, found himself called to the chair of botany and horticulture at the new Agricultural College of Iowa. He found "A few slender sticks" for trees, one building for the College, an old farm house, and two homes for Professors, in an open field, parts of which were later ploughed up to grow potatoes and corn. Inside the building there was no apparatus of any kind—not even a microscope. His first class of forty-three students was chiefly occupied with descriptive and systematic studies—for which purpose the class simply moved out on to the campus. In the winter of 1870-71 a compound microscope was purchased. This was placed on a table with some simple reagents and each student was allotted a period for microscopic study. On the door of the room was nailed a sheet of cardboard bearing the legend "Botanical Laboratory." No doubt the other professors jeered, but botany had come to stay.

Space does not permit of a citation of the gradual advance, diversification and deepening of American botany under such leaders as Gray, Farlow, Goodale, Bessey, Arthur and Coulter, or of the books which mark the successive stages. In many respects the remarkable parallel is afforded with comparable developments in teaching and research in British universities. Coulter himself stood for a science of the widest possibilities, and as editor of a journal of increasing influence was able to give his views a wide publicity. Indeed, his facility with the pen aided the spoken word, and his keenness as a promoter and supporter of new movements, may not be his least title to pre-eminence.

From 1880 onwards Coulter's output of work was surprising both for its amount and the diversity of interest which it disclosed. Thus there were studies of floral development, of the stamen, the embryo and the ovule, and of what may be described in general terms as physiological anatomy. By the year 1885 we may suppose that the teaching of botany in the United States was beginning to be more or less on an even footing with that in Europe, the work of De Bary, Strasburger, Sachs, Prantl and Vines being then in general use in American laboratories. The microtome was coming into general use and detailed studies of difficult materials correspondingly intensified. Cytology, gymnosperms and fossil material began to receive increasing attention. Coulter was associated with many of these developments, both directly and through his editorial activities, but his overriding interest was still taxonomic. In the survey of the vast territory of the United States there was still much ground to cover. Associated with

work the studies of plant geography and ecology developed apace

Coulter became president of Indiana University, then of Lake Forest College and finally in 1896 was elected to the chair of botany in the University of Chicago. The great days of American botany had arrived. A huge endowment, a matter of a million dollars, made possible the creation of the Hull Botanical Laboratory. Here Coulter's administrative experience stood him in good stead, and he soon had organized a representative department and had recruited to his staff young men with particular aptitude for the several special branches. Of such, for example, was Chamberlain, whose skill as a technician did much to advance anatomical and morphological investigations.

At the turn of the century Coulter, in the midst of any other activities, was still deeply involved in economic work. Thus, in collaboration with Rose, published, in 1900, "A Synopsis of Mexican and Central American Umbelliferae" and a "Monograph of North American Umbelliferae". At this time he was also gathering laurels as a morphologist and, together with D. H. Campbell, was elected to the American Academy of Arts and Sciences in 1898. The early years of this century saw the publication, in collaboration with Chamberlain, of the books by which he is probably best known to botanical students.

Great Britain, namely, those attractive books on "Morphology of Spermatophytes Gymnosperms" and "Morphology of Angiosperms". Together with his other papers and essays (on such themes as evolution, religion and science, etc.), his output of work was formidable. Coulter was, as his biographer remarks, "a prodigious worker and a lover of writing"—and it might be added of lecturing and public speaking. Indeed, it is not too much to say that he took a share, and a productive share, in all that was going on, and hence his work serves as an indication of the general trend of American botany. The developments in botanical science during the first three decades of the century cover more familiar ground and need not be considered in detail here.

There can be no doubt as to the interest and value of the work which Mr. Rodgers has undertaken and ought to fruition. On occasion, perhaps, one may entertain doubts regarding his sense of values—as, for example, when at various points he extols Coulter as a man of vision and prophet of the future of botany but this may well be true if restricted to its American context. Again, the American reaction to the controversy between science and religion during the Darwinian and post-Darwinian period, though, one feels, have been given more incisive treatment. There is also a question of the final evaluation of Coulter's contribution to science. Probably it is not soon to come to any decision. It may be that in reading himself over so many aspects of his subject and he left few untouched—he failed to make that major contribution which comes from concentration of effort and singleness of purpose, in other words, that he lost in depth what he gained in breadth. It may also be that the best use of his talent was not one to which he actually put it, that is, for the general advancement of a new science in a new country.

Lastly, in these days of books produced "in conformity with authorised economy standards", it is a pleasure to handle a work so clearly printed and so handsomely bound.

C. W. WARDLAW

SCIENTIFIC METHOD AND SOCIAL PROBLEMS

Race Relations and the Schools

A Survey of the Colour Question in some aspects of English Education, with a number of Proposals and Suggestions. Foreword by Dr G. P. Gooch (League of Coloured Peoples, 19 Old Queen Street, S.W.1.)

Social Differences in English Education

By T. H. Pear (From the *British Journal of Educational Psychology*, 14, Part 3) 7s. 6d.

IN his highly appreciative foreword to "Race Relations and the Schools", Dr G. P. Gooch lays it down that "conduct as a rule is determined by tradition and sentiment, and it can only be changed by greater knowledge, wider imagination and deeper insight". He reminds us that "their traditional values and way of life are as real and precious to coloured peoples as are ours to us, and that we can be proud of our own civilization without exhibiting a complacent and justly resented superiority complex".

Convinced that the race problem in the British Empire needed careful reconsideration, a group of English representatives of education, whose names and positions command the utmost respect, resolved to undertake a survey of the relevant contents of text-books of geography and history commonly used in British schools, both elementary and secondary. The results were certainly revealing, and constitute little less than a broad black blot upon the educational schemes of such a nation as ours. The investigation revealed, in fact, that in our school text-books, the life and needs of the sixty-five million coloured peoples of the British Empire, excluding India, are almost entirely ignored. This will never do. The days of exploitation are happily a thing of the past, and the days of benevolent trusteeship are at hand. The critical eyes of other nations are turned upon a nation which in the course of history has succeeded in painting a large part of the map of the earth's surface red, and criticism must be met with a clear conscience. This comprehensive report, which includes an examination of school-books, suggested methods of dealing with the colour question, and a useful bibliography, points the way to desirable changes, not extensive but nevertheless significant, in school-books, in training courses for teachers, and in films designed for educational purposes. The report is informed throughout with the spirit of scientific method.

Still more obviously—and one may even say unrelentingly—does the spirit of scientific method pervade Prof. Pear's paper on "Social Differences in English Education". He points out that English social stratification occasionally interests historians and economists, but that a psychological approach to the subject is rare. Psychologists are "blameless for the innocence of psychology displayed by the framers of the Norwood Report, and of the White Paper on education". He quotes a writer in the *New Yorker* who says that "from the rash and impetuous American viewpoint the English educational system, to our innocent eyes, has always seemed caste-ridden and money-dominated". Yet, adds Prof. Pear, there has been a taboo upon considering psychologically (that is, scientifically) these aspects of the system. In breaking this taboo he is well

aware that he may be asked what are his qualifications for the necessary degree of scientific impartiality and aloofness, seeing that a man can no more get away from his own upbringing than he can get away from his own shadow. To meet this objection, he gives enough of his personal history to enable the reader to judge for himself.

At an early point in his inquiry, Prof. Pear states a curious fact which has probably escaped the attention of many serious students of psychology. No living English professional psychologist appears to have come from any of the great public schools, no matter how strictly or loosely you define 'great'. We have no account of his social psychology, "written by one who not only sympathises with but 'empathises' their special culture pattern". We lack also a corresponding description of his way of living by a proletarian psychologist. Until recently, "our English social psychology has been written by the middle class about the middle class". He says this fact is well known, it is no doubt well known to some people.

Prof. Pear concludes his fresh and interesting investigation by expressing his full agreement with Prof. D. W. Brogan's opinion, that "politically England is a democracy, perhaps the most mature democracy in the world. But democracy is not merely a matter of government—it is an attitude to life. And England will not be a full or anything like a full democracy as long as one of the kindest and most united peoples in the world is internally divided in a fashion that impoverishes the national life".

Such is the verdict of one who has done his utmost to pursue scientific truth, wherever it may lead him.

T. RAYMONT.

NATURALISTIC PHILOSOPHY

(1) Verifiability of Value

By Ray Lepley (Columbia Studies in Philosophy, No. 7). Pp. xi+267. (New York: Columbia University Press, London: Oxford University Press, 1944.) 22s. net.

(2) Naturalism and the Human Spirit

Edited by Yervant H. Krikorian (Columbia Studies in Philosophy, No. 8). Pp. x+397. (New York: Columbia University Press, London: Oxford University Press, 1944.) 30s. net.

THESE two books are expositions of the naturalistic philosophy now popular in the United States and mainly derived from the teaching of John Dewey. The starting point is the view that scientific methods of investigation are valid for all spheres of thought and action. These Naturalists, however, do not use the arbitrary restrictive criteria of truth and verifiability of the Logical Positivists, and therefore their theory does not run counter to actual scientific practice as Positivism does. So far as the argument in Lepley's book is designed to show that judgments of value can be accommodated within the scientific scheme just as easily as judgments of fact and that they do constantly occur, it is evidently sound. Those essays in Krikorian's book which are straightforward inquiries into specific subjects are well done. Thus, Eliseo Vivas on "A Natural History of the Aesthetic Transaction", George Boas on "The History of Philosophy", Edward W. Strong on "The Materials of Historical Knowledge", the editor on "A Naturalistic View of Mind" and, especially,

Ernest Nagel on "Logic Without Ontology" make valuable contributions to their subjects—so far as they go. These essays display the best aspect of Dewey's teaching; they are careful, fair-minded, undogmatic.

It is when they come to questions which are more genuinely philosophical, those concerned with underlying presuppositions, that writers of this school tend to shirk or fumble. Lepley, in the first volume, argues that judgments of fact and of value, descriptive and normative judgments, occur together inseparably connected and that both sorts are found equally within the sphere of science, as ordinarily understood, and the spheres of art and morals; that verification in science, though perhaps simpler and easier, is not radically different from verification in art or morals. All this may be granted. But he fails to observe that discussion on matters of art and morals constantly turns on questions of ends, distinct from questions of means where the factual and causal element enters. In scientific discussion ends are taken for granted and are not discussed, so that all ordinary judgments that are in any way valuational or normative are judgments of means only. Lepley does not consider whether a judgment about an end, say truth or justice, can be dealt with naturalistically. Whether science can produce criteria to judge the value of its own method.

Similar defects appear in those essays in the second volume which should deal with such problems. In the one on "Naturalism and Democracy" by Sidney Hook, we are given to understand that the justification of democracy is that it is an experiment designed to realize certain moral ideals which is in fact successful, also that the moral ideals are hypotheses requiring empirical verification. Thus, if Hitler had won the War, the writer would presumably have decided that the democratic experiment had failed and the related hypotheses were false. Both Hook and Sterling P. Lamprecht, who writes on "Naturalism and Religion", consider that there is not enough empirical evidence to justify the hypothesis of theism, but the evidence is not examined, nor is there any attempt to discover those ends of thought and action of which religion is the expression. The writers appear to be following fashionable opinion instead of examining their presuppositions. Similar criticisms apply to other essays. This does not mean that their presuppositions are not in fact sensible or that their positive statements also sensible. It only means that they have neglected their philosophical duties. Nothing is said to prevent Naturalism from sinking to intellectual indolence. Science is fashionable, so let us call our opinions on any subject scientific and then stop thinking.

The essay on the Naturalism of Frederick Woodbridge by Harry Todd Costello (containing a pleasant story about Bernard Shaw) is puzzling, as are the other references to Woodbridge, because no writer in recent years has so neatly and effectively displayed the defects of Naturalism ("An Essay on Nature", 1940, p. 265ff). Three other essays should be mentioned. One, on "The Unnatural", a good piece of metaphysical argument, seems rather out of place among its companions. One, on "Naturalism and the Sociological Analysis of Knowledge", may be excellent but is written in a difficult dialectical jargonese. Finally, there is an essay by the octogenarian Dewey, who attacks the things he dislikes with a vigour that puts more youthful disciples to shame.

A. D. RITCHIE

CO-OPERATION IN THE WAR AGAINST DISEASE

By SIR PHILIP MANSON-BAHR, C.M.G.

THE modern statesman is inclined to reject the terms of narrow nationalism, both in commerce and policy. He maintains his faith in the development, for the public good, of such co-operation and good-will which cannot be compatible with international mistrust and concealment. He is impelled to adopt this view, it is hoped, by the ideals of humanitarianism no less than by logic which implies search for efficiency. Yet it is self-evident that at present, without a radical change in method of government, which would go beyond political imagination, the control of geographical areas, or countries, must rest with the people of those areas. How far this control should be sovereign is a matter for debate, but there is little doubt that, in the matter of transmissible disease, the safety of the whole world community ought to take precedence over the rights of any particular people. In this respect there is one subject into which political considerations do not intrude and that is the advisability of a united, co-ordinated policy in the war against disease. This stands for the communal good. It is therefore opportune to formulate some ideas how such a campaign may be conducted. The causes of the main tropical and subtropical diseases are now well known, their conveyance to man and their effective treatments accurately ascertained. A proviso should here be made that the diseases, so named, may also be important in temperate lands. To illustrate this point, reference may be made to certain of these diseases and to some of the reasons which compel international attention. In this article, certain problems will be briefly stated and certain lines indicated which appear indispensable to their solution.

Malaria is perhaps the commonest disease in the world, it takes a heavy toll of infant life and causes more incapacity than most people realize. But it is not a static disease, it may, from time to time, appear in epidemic form and as such spread over international boundaries. To understand this it is necessary to comprehend something of the modes of spread of this disease, which is a complex partnership between the parasite, the mosquito, and man.

The cause of malaria is, of course, the malaria parasite, of which four species are recognized in man, they differ from each other in appearance and in their effects. The most dangerous is undoubtedly the malignant tertian parasite, which is particularly tropical in its distribution—though found as far north as Italy, Greece and Rumania—and which is the essential cause of the much-dreaded blackwater fever, a sequel which has cost the lives of so many Europeans in Africa and elsewhere.

The limited range of this parasite is explained by the ascertained fact that it requires a higher atmospheric mean temperature to complete its development inside the mosquito. It is one of those unexplained, and at present almost inexplicable, facts of biology that only mosquitoes of the genus *Anopheles* have been proved capable of transmitting malaria from man to man. In members of this genus the malaria parasite undergoes an essential stage of development before it is capable of once more

infecting man, but for the essential points in the present argument it is necessary to realize that not every member of the genus *Anopheles* is able to transmit malaria, that of those species which can do so, some are highly effective and others less so, that their effectiveness depends largely on the degree to which a species seeks human blood rather than that of animals, and that the effective spread of malaria depends upon the ability of efficient carrier mosquitoes to herd in close association with man.

Of efficient carriers there are at least six in Africa and many more in Asia. For breeding, some species need water open to the sun, others demand shade, some need relatively high temperatures, others prefer cool waters, some even require brackish water which is prohibitive to others, some need clear, limpid streams, others will breed in a muddy water-filled hoof-print. Then different species of *Anopheles* have characters which are relatively constant and are therefore vitally important. Thus a locality may be infested with *Anopheles* and yet have no malaria, but a change in agricultural habits of the people, for example, introduction of artificial irrigation, may so modify the composition or condition of the water that *Anopheles* of dangerous species, present in contiguous areas, may infiltrate, to initiate an epidemic of malaria in a population devoid of immunity.

In other circumstances the water may be suitable to the breeding of *Anopheles*, but these mosquitoes may not be present. If in such cases they are introduced, and, if persons carrying the malaria parasite in their blood exist in sufficient numbers, then conditions for epidemic transmission will have been created. This is the present position in certain groups of islands in the Pacific. *Anopheles* are not yet there, but may well be introduced in ships or in aircraft from other lands.

Again, malaria may be present, but the local *Anopheles* may be a relatively poor transmitter, so that the disease is maintained at a low rate of incidence, but if to such a community a vigorously breeding, man-loving *Anopheles* is introduced, the result may be an epidemic of malaria lasting many years, in which the human death-roll may amount to tens of thousands. This is not speculation, but is exactly what happened to Brazil about 1930, when that most versatile malaria-carrier, *Anopheles gambiae*, was transported from West Africa to Brazil in the fast steamers which ran between Dakar and Natal (a port in Brazil), became established there and carried death and ruin to a large peasant population for ten years. At the cost of enormous exertion, this mosquito has at last been eradicated from Brazil by the combined efforts of the Government and the Rockefeller Foundation, and the epidemic has ceased, but though the organization which made this great feat possible was brilliantly conceived and should serve as a model for the world, the tragic episode underlines the overwhelming truth of the old adage that prevention is better than cure, and prevention would be difficult without co-operation between sovereign States—between the country from which the mosquito originated and that to which it travelled. Prevention demands, for example, that no mosquito which may enter an aircraft at an aerodrome in West Africa should be allowed to escape on arrival in Brazil—the authorities at each end must take their complex precautions. Moreover, the work of eradication of *Anopheles gambiae* from Brazil was assisted

by—note the title—the International Health Division of the Rockefeller Foundation. India also has its own malaria problems, but India knows no *Anopheles* so vicious as *Anopheles gambiae*, and it is conceivable that this mosquito, to which West Africa owes most of its evil health reputation, might be taken by aircraft to India, there to repeat its Brazilian feat. Thus the rapidity of modern travel has raised problems previously unknown.

It is therefore clear that prevention of malaria on an international scale entails the close co-operation of specialists in many directions. It demands the mutual understanding between doctors, entomologists, agriculturists and irrigation engineers, without this an individual alone is helpless. The medical entomologist is there to identify the *Anopheles*, to detect its breeding places and to direct methods for its eradication. To give some idea of the technicalities involved it has to be pointed out that there are variations even in one species which are of great importance. Thus *Anopheles maculipennis*, the chief transmitter in Europe and North Africa, is divisible into no less than seven races in the Old World and one in the New, which can be distinguished from one another (like birds) by the colour pattern of their eggs. Some are important species in the present sense, others not at all.

What is true of malaria bears a definite relation to another great mosquito-borne disease—yellow fever “Yellow Jack” once destroyed one of Napoleon’s armies in the West Indies and frustrated the French attempts to force a canal through Panama until finally defeated by the Americans under General Gorgas, it was the terror of Caribbean sailors and West African traders, the pernicious and deadly jaundice which gives it its name was the origin of the yellow colour long ago adopted, and still maintained, for the quarantine flag. Yellow fever is caused by an ultra-microscopic virus, a group of organisms the members of which include the causes of measles, influenza, smallpox and numerous plant diseases, and this virus is transmitted from the blood of infected man to that of a healthy individual by mosquitoes during the act of biting. Unlike human malaria, yellow fever is a disease which affects certain wild animals, particularly South American monkeys, opossums, which constitute a reservoir of disease that must be taken into account, and it is transmitted chiefly by mosquitoes of the genus *Aedes*, of which the most important is the semi-domestic species—the tiger mosquito—*Aedes aegypti*.

These mosquitoes are abundant throughout the tropics, in America, Africa and Asia, but yellow fever has fortunately not hitherto been known in Asia and Australia. Should the virus be introduced there, the stage would indeed be set for an epidemic the like of which has, perhaps, not yet been known, and although there is a vaccine which, when inoculated, affords excellent protection, inoculation of the millions of people in India and the Far East would be such a gigantic task that it is preferable to take the most extensive and radical measures to prevent the entry of this disease.

But an infected mosquito might enter an aeroplane in Africa and escape from it in India, might infect a villager who in turn might infect a dozen local *Aedes*, and so on. Or, again, a man in Africa might travel by air to India during the incubation period of the disease before recognizable symptoms develop, on arrival the disease might not be readily diagnosed, and in the interval he might easily infect local Indian

Aedes aegypti. All this is, of course, well recognized, and active precautions are being taken to guard against such happenings, but it is by no means easy to realize how detailed and how fine must be the system which attempts (so far with success) to protect the East against yellow fever. One crucial point in this protective system is international co-operation. Each threatened country must take its own precautions, but each already infected country has a responsibility to ensure that aeroplanes departing from its aerodromes do not carry with them infective material, human or otherwise. International conventions have indicated how these responsibilities should be met.

African trypanosomiasis (sleeping sickness) has for centuries played havoc with the natives of that disease-ridden continent, but as yet this affliction is confined to Africa. It is caused by a tiny protozoan in the blood, which is picked out and transmitted in the act of biting, by tsetse flies. It is, again, one of the unexplained mysteries of biology why this organism is so selective that it cannot be transmitted by mosquitoes (apart from occasional mechanical transmission by certain other biting flies), and that it cannot undergo its essential development in insects other than the tsetse, yet the fact remains.

In the days of slave trading, negroes suffering from sleeping sickness were often transported to the West Indies. They died there of the disease, yet sleeping sickness was never established in the western hemisphere, because the requisite flies did not exist there. The tsetse is a land fly, it does not frequent harbours, it has no incentive to get aboard ship, but it does seek shade, and may be attracted to the shade of an aeroplane standing near a patch of trees on an aerodrome, it may enter the aeroplane and travel with it, and if living infected flies were to reach parts of America and become established there, there is little doubt that the disease would be propagated. The danger is, perhaps, somewhat remote, but the discovery of dead tsetse flies in aircraft arriving in Brazil has been regarded as something of an omen by the South American authorities.

These three diseases illustrate the fact that in warm climates some of the major dangers to health are transmitted from man to man, or from animals to man, by flying insects. But there are great epidemic diseases, conveniently labelled tropical because their present incidence is mainly in hot countries which are, in fact, diseases of all climates and which are transmitted by arthropods which do not fly.

Plague was more than once rampant in England—the Black Death and the Great Plague were instances of spreading epidemics—and is now present in the rodents of the United States, as well as of Africa and Asia. It is essentially a disease of rats and field rodents, and is spread among them by their fleas. Fleas leave dead animals, and in default of living rodents on which to feed, will attack man. The cause of plague is a bacillus which is present in the blood of a diseased animal, and which is taken up by the flea when it feeds. In the flea it multiplies, and, in certain circumstances, may be injected into another animal (or man) at a subsequent feed. There is thus the cycle rat-flea-rat, and if the mortality among rats is high, and the chance of feeding on rats consequently low, and if the rat community is in close association with man, there is a spill-over of plague to man, which, in extreme conditions, may be

at proportions, with devastating epidemics. Rats, of course, seek food which is to be found especially in human habitation, or in food stores, in bazaars in the East, and in ships. They are great climbers, and a dock area heavily infested will, unless transit is prevented, both give to and receive from incoming ships considerable numbers of rats. An infected rat may invade a ship, start the disease in the ship's rats, and an infected rat may leave the ship at another port, infect the rats of that port, and originate an epidemic in man. This course of events has happened often in the past and the danger is always present. There has recently been an outbreak in Haifa and in Haifa, the rats of Rangoon and Hawaii have been infected for many years, human deaths from plague are constantly reported from Istanbul, in India, Java, and Madagascar plague in man is constantly present.

Plague, therefore, is a disease which is peculiarly associated with commerce and trade routes, with ships and shipping. These are pre-eminently the international links, and it is just here that control measures must be, and indeed are, co-ordinated by international agreements.

Typhus, which Zimsser regarded as a more potent factor of the fate of nations than the Caesars or poleons of history, is transmitted from man to man by the louse. It is caused by a minute organism which is taken in by the louse when it feeds. Typhus flourishes when lice flourish, in cold weather when the thing is not often removed, and particularly when civil life is disorganized by war, with its masses of refugees herded together and without the means of cleanliness, or in famine, when the people flock to the great cities and live in crowded conditions, as in North Africa. Typhus killed more people than all the weapons of war in 1914-20, in the present War the attention given to it by the Germans indicated its relevance they were not anxious to admit. In North Africa the incidence has been heavy during the last few years, in China the refugees from invasion were widely diseased, in Spain a violent epidemic followed the civil war. The introduction of typhus into a crowded community, which is already infected with the necessary lice, may produce the final condition needed for an outbreak.

Those diseases which are not specifically insect-borne present problems not less complex and not less urgent. Cholera may be introduced into a country by the movements of labourers, by pilgrims or by refugees from war, smallpox has many times invaded tropical countries in the same way, the common enemies of childhood, such as measles, at one time wreaked havoc in Fiji, where the natives had no immunity, and the same course of events has recently been enacted in remote villages traversed by the newly built Alaskan highway. The same thread runs through these happenings—the introduction into one area of diseases prevalent in another, across national boundaries.

Moreover, there are less spectacular diseases, such as tuberculosis, leprosy, venereal diseases, yaws, hookworm infection, unevenly spread over the tropics but affecting grossly the health and happiness of enormous communities, and their eradication could not satisfactorily be undertaken by the uncorrelated actions of individual States. These are the responsibilities of Governments, but the resources of some of the tropical countries are totally inadequate to their needs. At the root of much of this chronic illness is the poor state of nutrition of the people, the poor

state of agricultural knowledge and equipment and the low state of general hygiene.

The science of nutrition is still in its infancy. This sounds a queer statement, as the desire for food and the adequate nutrition of the body is surely a primitive instinct. So it comes as a rude awakening to realize that lack of proper ingredients in the diet is at the root of most human evils. Just as weeds will grow and flourish on poor soil, so will the germs of disease when the defence mechanisms of the human frame are weakened by insufficient nutriment.

It has now been established beyond doubt that the majority of tropical peoples are existing on grossly insufficient foods. This is especially the case in the West Indies, Central Africa and China. There the native foodstuffs do not provide the necessary amount of proteins and fats. Some tribes are undernourished because they do not eat meat or drink milk, even when they are at hand. There are taboos, traditions and beliefs—all so ingrained that it may take centuries of education to eradicate them. There can be no reasonable doubt also that wrong feeding is one of the principal causes of the very high infant mortality in most tropical countries.

The main facts are summarized in the two reports of the Economic Advisory Council on Nutrition in the Colonial Empire published in 1939. A study of this mass of information makes illuminating reading and strengthens the belief that the subject of nutrition is all-pervading and of the utmost importance. It is the ground rock of health and one which underlies the maintenance of virile and healthy populations. It strengthens the belief, if proof were needed, that if the soil of the body is defective, no medical skill or specific drug treatment can be effective in eliminating the seeds of disease.

The argument sustained by these facts is that the responsibility of the advanced countries to their own peoples demands that they should urge the less advanced to prevent the export of transmissible disease, as well as that they should themselves prevent its ingress. The less advanced must be persuaded to adopt those sanitary measures, those quarantine restrictions, that the community of nations considers necessary to general well-being. But the advanced have a human responsibility to the uneducated peasant populations of other lands, which should not be estimated on a safety basis or on a cash value. Self-interest is not a policy that can appeal much to a world which wants a faith, and in medicine more than in any other human activity there is need for co-operation and the pooling of resources on the widest scale.

To be more precise, the Government of each nation must do its utmost for the health of its own people, must protect its own people from disease brought in from abroad, must ensure, so far as possible, that reasonable steps are taken to prevent the export of its own diseases, and must be prepared to place at the disposal of the rest of the world reports on its own health and swift news of any major epidemic outbreak. The last, indeed, has already been the rule on a large scale, and before the War the Far Eastern Bureau of the League of Nations at Singapore issued early warning of the great tropical epidemic diseases throughout its area. The Pan-American Sanitary Bureau, and the Paris International Office of Public Hygiene performed like functions. But these organizations were not world-wide, they were not complete, and the position cannot be satisfactory until completeness is achieved.

Again to be precise, the controlling Governments of tropical Colonies must render to those Colonies services more regulated by their needs than by their capacity to pay. These services, in the matter of health, include education and research, equipment and personnel on a scale not often attempted, and embracing not only medicine but also agriculture, animal husbandry and industrial development. Moreover, it is a moral responsibility for the more advanced nations to lend to the less fortunate nations, without thought of reward, the services they need, even if those less fortunate peoples are self-governing.

Apart from good-will, high ideals and financial help, the essential basis for this co-operation between nations is knowledge. First, there is the knowledge of the outbreak of transmissible disease. This information must be given by the affected country to a central organization with the utmost speed and accuracy, so that spread to other countries may be prevented.

Second, there is the knowledge of the general state of health of these countries. Much of this can be, and in fact is, contained in official annual medical and health reports, but for many of the countries of the tropics such reports are difficult to obtain, or are not made. Any person interested in the health conditions of the British Crown Colonies, or of certain tropical dependencies of other nations, has at his disposal a satisfactory range of annual reports, but some other countries, of great importance to world health, do not offer this service.

Third, there is the knowledge of the complex problems of disease, which is being slowly and painfully acquired by research workers and investigation throughout the world. This knowledge is made available through the medical journals of all countries, which now make up a mass of literature so great, and in such a multiplicity of languages, that few workers even in restricted subjects, and none in wider fields, can hope to read all that should interest them. Outstanding achievements soon receive universal recognition, but each outstanding discovery is followed by a mass of investigation which modifies and re-assesses its application and value. It is necessary that accounts of this work be assembled by some agency in a form convenient for those who, desiring to know of it, are unable themselves to perform the tedious task of searching the literature.

Apart from the international aspect of this problem, the British Empire has a definite responsibility towards the many peoples over whose welfare it presides. Promotion of medical knowledge and raising the standard of health in every portion of the globe is the best method of securing good-will and strengthening the machinery of government. Medical education is being extended on British lines in India, Ceylon, Africa and elsewhere. The needs of native medical schools and practitioners has to be catered for by the dissemination of knowledge. It is therefore eminently desirable that Great Britain should take an honourable place in the provision of medical information suitable to its world-wide responsibilities. To strive for such an ideal is surely not beyond the powers of a nation which has stood shoulder-square to the perils of the last five years of war.

I wish to express my indebtedness to Dr. Charles Wilcocks of the Bureau of Hygiene and Tropical Diseases for his helpful advice and assistance in the compilation of this article.

AUTOSYNTHETIC MOLECULES

By DR. T. F. DIXON

KNOWLEDGE of the mechanism of cellular protein synthesis has been advancing rapidly with the aid of the ultra-violet and electron microscopes. Nucleic acids show characteristic light absorption maxima at 260 $m\mu$, due to the purine and pyrimidine constituents which distinguish them from other substances in biological material. By using a quartz microscope with monochromatic ultra-violet light, information has been obtained about the role of nucleic acid in cell division¹ and the nucleoprotein nature of the chromosome and gene^{2,3}. Indirect evidence for the latter has been obtained by ultra-violet irradiation of germinal tissue, when high efficiencies of mutation have been observed at 260 $m\mu$.⁴ Viruses also appear to be nucleoproteins.

All animal and plant cell nuclei give positive Feulgen reactions, indicating the presence of deoxy-pentose, whereas pentose is characteristic of the cytoplasm. Variations occur not only in the sugar and pyrimidine components of the nucleic acid portion and its degree of polymerization, but also in the proportion and nature of the protein with which the nucleic acid is combined. Thus nuclear material from fish sperm heads (the classic example) contains approximately 2 parts of nucleic acid combined with 1 part of the strongly basic protein protamine, whereas in tobacco mosaic virus nucleoprotein 6 parts of nucleic acid are linked with 94 parts of a less basic and more complex protein. The nucleoproteins may form complexes with lipids. For example, the viruses of Rous sarcoma⁵, equine encephalomyelitis⁶ and the elementary bodies of vaccinia⁷ have been shown to be associated with phospholipid-nucleoproteins.

The word virus has been applied mainly to agents residing in multicellular organisms, and when individual free-living cells are the hosts, such as bacteria, they are referred to as bacteriophages. The property of obligate parasitism or infectiousness has been found to be associated with certain high molecular weight nucleoproteins which are foreign to the host proteins and are probably the viruses themselves. In many cases one attack of virus disease in an animal may produce a lasting immunity demonstrable by certain serological phenomena such as complement fixation, agglutination, precipitation and neutralization. Enduring immunity may depend on the kind of tissue infected and probably due to a long-term sojourn or persistence throughout the life of the host. Lasting immunity may not be obtained to influenza or to the common cold virus because the superficial cells lining the respiratory tract are being thrown off at intervals and replaced by deeper cells, and thus do not provide a permanent abode for these viruses. The fact that injection of immune or convalescent serum has little influence on the course of some virus diseases is not surprising when it is considered that the viruses are multiplying within the cells and may never be subjected to the action of humoral antibodies.

Certain cancerous growths are associated with viruses. Such growths are transplantable, and agents with which the disease can be produced again can be extracted from them. Thus viruses are responsible for tumours of the renal epithelium of frogs, for

variety of mesodermal growths of fowls and for papillomas of rabbits. In some cases viruses may be the causal agents, and the chemical carcinogens the 'provoking agents'. The 'milk factor', the transmissible agent of mouse mammary cancer, may cause no growths until it is 'provoked' by an oestrogen. That anti-viral antibodies frequently attain great strength in the blood of virus-induced tumours without preventing their growth is probably due to the selective permeability of the cells, which will neither admit haemolysins or antibodies against bacteria nor those against viruses. The cell itself may be regarded as the host of the tumour virus, and not the organism which becomes implicated secondarily.

The nucleoprotein viruses of animals, plants and bacteria differ in size, stability and chemical composition. Their sizes⁸ range from the larger, more complex and organized viruses such as vaccinia with a diameter of 225 m μ and an estimated molecular weight of 4.3×10^9 , to the smaller viruses such as foot-and-mouth disease with a diameter of 10 m μ and a molecular weight of 4×10^6 , which perhaps may approach the minimum limit of size for self-reproducing particles. As an obligate parasite, vaccinia, or any other highly organized virus, may possess only a portion of the enzyme systems necessary for existence, relying chiefly on the intracellular nuclei for complementary systems enabling it to multiply. Although no independent metabolism of vaccinia has been demonstrated *in vitro*, it has been shown that copper, flavin-adenine-dinucleotide, biotin, phosphatase and catalase are present⁹. On the other hand, lipase, catalase and phosphatase were adsorbed from their solutions by the virus with ease and could not be readily eluted, so that it is difficult to distinguish between the enzymes which may represent an integral part of the virus and those which may be contamination from the host. In contrast to the simpler plant viruses, the more complex animal viruses such as vaccinia, psittacosis, yellow fever or lymphocytic choriomeningitis give rise to more than one specific antibody.

Electron micrographs of vaccinia indicate six rectangular plane surfaces and five dark areas¹⁰, showing in many ways resemblances to bacteria and marked differences from plant viruses. Tobacco mosaic virus particles appear as rods 280 m μ long and 15 m μ across, representing a molecular weight of about 4×10^7 . Bacteriophage suspensions consistently show the presence of sperm-shaped particles adhering to bacterial membranes¹¹. The particles consist of heads 80 m μ in diameter and thinner tails 130 m μ long, and in the presence of sensitive bacterial cells absorb by either head or tail. X-ray diffraction studies on tobacco mosaic virus¹² show that it is built up of hexagonal prism units 8.7 m μ tall and 7 m μ across, with a molecular weight of 3.7×10^6 . There are also transverse spacings and demarcations at 4.4, 2.2 and 1.1 m μ . It may be speculated that during self-reproduction, the assembling of these units of 1.1 m μ cubes, containing perhaps eighteen amino-acids, leads to the construction of a layer, and that the virus may consist in part of similar layers joined by nucleic acid fragments.

The production of a mild form of a disease to create an active protection has long been known generally, as with bacteria, it is not practicable to produce an artificial protection with small amounts of a fully virulent virus under conditions corresponding to natural infection, since there is the danger of provoking a severe attack in a susceptible

patient. Unlike bacteria, viruses cannot usually be treated with formaldehyde or other chemicals *in vitro* to destroy their virulence without losing their antigenic properties in a parallel manner, although they may lose their virulence or their tropism for a particular tissue by repeated transmission through another host. Long-known examples of modifications of viruses which can induce protection are the Jennerian cow-pox, probably arising as a mutation of human smallpox, and the modified Pasteur rabies virus produced by brain-to-brain passage in rabbits. A third more recent outstanding example is the yellow fever virus strain 17D which was evolved by hundreds of passages in tissue culture in media containing embryonic tissue from which neural tissue had been removed. The resulting virus lost its neurotropic character and has been widely used for human immunization¹³. Nothing was known concerning the chemical changes involved in the production of a given variant until amino-acid analyses were performed on six mutant strains of tobacco mosaic virus each producing characteristic leaf symptoms and which had been prepared in essentially pure form. Briefly, besides serological differences, tobacco mosaic, green and yellow aucuba, J14D1, Holmes masked and ribgrass strains showed differences in their contents of tyrosine, tryptophan, phenylalanine, arginine and sulphur. In addition, the ribgrass strain contained histidine, which was not detected in the others^{14,15}. Attempts to alter the tobacco mosaic virus *in vitro* have been made by preparing acetyl-, phenylureido-, carbobenzoxy-, *p*-chlorobenzoyl- and malonyl-derivatives¹⁶. Providing the reactions were not carried too far, a large portion of the amino- and phenolic-groups could be combined without loss of infectivity. Although the derivatives failed to perpetuate themselves as such and the virus eventually isolated was the ordinary tobacco mosaic virus, it is hoped eventually to obtain known structural changes in a virus which will be heritable.

Both virus and gene have the ability to reproduce within, and only within, certain living cells, and may undergo changes spontaneously or as a result of external factors. That new virus strains appear to become dominant when grown in an unnatural host suggests that the altered environment of the host may supply different building blocks. In general, a chemotherapeutic agent deprives an organism of essential enzymes or metabolites. It may do this, with bacteria, by interfering with capsule formation or by altering cell permeability so that essential metabolites are either washed out of the cell or fail to penetrate it. Or there may be competition with a structurally similar essential growth-factor at enzyme surfaces, as postulated for the sulphonamides and *p*-aminobenzoic acid. So far, the few viruses which have proved susceptible to sulphonamides, such as the agents of lymphogranuloma venereum, inclusion blennorrhoea and mouse pneumonitis, are those which in complexity and size occupy a position, perhaps analogous to the rickettsia, between bacteria and the smaller, less organized viruses, and their susceptibility may express their more complex needs and metabolism. Research into the metabolic requirements of the viruses offers an opportunity for a fundamental reasoned approach to their chemotherapy which has been lacking in the search for antibiotics. The susceptibility of organisms in general to virus infections when inadequately supplied with essential feeding-stuffs merits full investigation. In particular, bacterial viruses should serve

well for this study, since their growth can be observed quantitatively under controlled conditions

It has long been known that X- and γ -rays interfere with gene function and suppress organizer action, and that this is connected with the beneficial effects of radiotherapy in cancer. Recent work¹⁷ bearing on intracellular metabolism and the gene-cytoplasm equilibrium shows that these rays inactivate certain enzymes and viruses *in vitro*, and in proliferating and in incompletely differentiated cells produce an inhibition of desoxypentose nucleic acid synthesis in the nucleus and an accumulation of pentose nucleic acid in the cytoplasm.

Nucleoproteins are found in high concentrations wherever growth occurs in a living medium, whether in the metaphase chromosome, the normal gland cell, the avian neoplasm or the embryo. The cell was once considered the ultimate duplicating life-unit. Now the nucleus is thought to be the centre for protein synthesis, and the nucleic acids the essential units, either as polymerized desoxypentose nucleic acids associated with the gene proteins (of which chromosomins are stated to be a constituent¹⁸), or as cytoplasmic pentose nucleoproteins. Examination of the nuclei of rat liver cells has not revealed the complexity or concentration of the enzymes which are found so abundantly in tissues or organs¹⁹. This may be because the genes produce only formative enzymes of the sort used in protein synthesis. The use of radioactive nitrogen (¹⁵N) as a tracer has shown that nearly all body proteins even when fully synthesized are continually undergoing breakdown and repair and exist thus in a state of dynamic equilibrium, and this probably applies to the gene and cytoplasm proteins²⁰. When an oestrogen causes proliferation of uterine epithelium, when a carcinogen produces a sarcoma or when an evocator stimulates a gastrula to neural differentiation, certain circulating compounds may act on this gene-cytoplasm equilibrium in the particular tissue causing it to be reconstituted in a different way. Thus at a critical instant in the life of the tissue, a crucial cellular reaction may be influenced, causing differentiation to proceed towards one type of cell or another. Although knowledge of the intricate processes occurring in the cell is very far from complete, the pattern of organization and nuclear structure is just beginning to appear.

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THE SUPER-FLUIDITY OF LIQUID HELIUM II

THE study of the properties of liquid helium has been very fruitful in revealing unexpected phenomena—super-conductivity, abnormally high thermal conductivity, super-fluidity and others. Of these, super-fluidity and some associated effects are comparatively new and were being investigated in several laboratories just before the War. Prof P Kapitza, who is one of the chief workers in this branch of low-temperature physics, and who introduced the term 'super-fluid', has recently published an article¹ in which he surveys his work on this subject and discusses possible explanations of the flow phenomena.

When helium is progressively cooled below 4.2° K (the liquefaction point) under atmospheric pressure a change takes place at 2.19° K, the λ -point. The most obvious effect is the sudden cessation of boiling. The change is usually referred to as the passage of helium I into helium II, and the peculiar properties of liquid helium are associated with helium II, for example, Keesom found that the thermal conductivity of helium II in a capillary was many times greater than that of the best metallic conductors.

Kapitza repeated Keesom's experiments under somewhat different conditions and obtained still higher figures for thermal conductivity. It was while seeking an explanation for this effect that he was led to the idea of super-fluidity and to the carrying out of experiments² which proved that the viscosity of helium II is vanishingly small. The normal mechanism of heat conduction—the handing on of thermal agitation from molecule to molecule—could not apply in this case, and the alternative appeared to be a form of conduction by means of convection currents; but, if this were the method, gravity was not a sufficient cause and convection currents must arise with extraordinary ease in helium II, implying that the liquid had an exceedingly small viscosity.

The latest determinations of viscosity have indicated a figure of 10⁻¹¹ poise as the provisional limit. This is a thousand-millionth that of water, and may be reduced still further if the sensitivity of the method can be increased.

Confirmation that powerful convection currents of a special type can occur in liquid helium II when a temperature difference is set up was obtained by Kapitza by means of the apparatus shown diagrammatically in Fig 1 (this and the other diagrams are from Prof Kapitza's paper, ref 1).

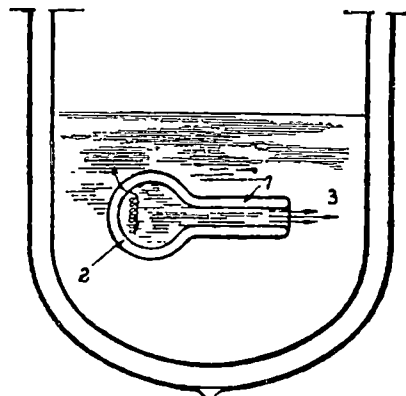


Fig 1

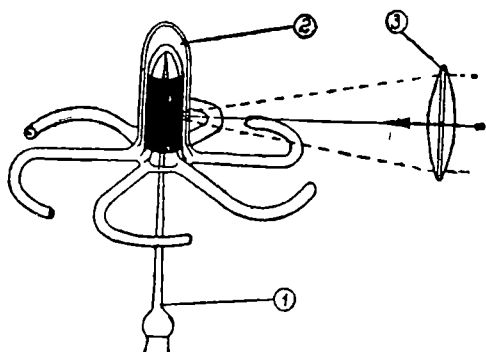


Fig 2

A small flask (1), open at the neck (3) and containing a heating spiral (2) was immersed in super-fluid liquid helium. When an electric current was passed through the spiral, a continuous current of helium was found to flow out through the neck of the flask. A delicate vane suspended in the neck was deflected by this current and served to measure its force and speed. An apparatus more suitable for demonstration purposes is illustrated in Fig 2. A cinematograph picture has been taken of this apparatus in action. A glass 'spider' mounted upon a needle (1) consists of a small bulb (2) provided with a number of outlet tubes which are all bent back in the same sense. When the whole spider was immersed in liquid helium II and the centre vessel heated by directing light on to the blackened interior by means of a lens, a continuous stream of liquid issued from each of the little tubes—the legs of the spider—although there was actually no through channel for liquid in the spider. As a result of the reaction of the escaping liquid, the spider was caused to rotate.

Reverting to Fig 1, the paradox of the experiment is that no return flow was ever detected with any position of the vane. The explanation first suggested for this was that the return flow might be in the form of a very thin mobile film along the glass surface. To test this theory, the wide mouth of the flask was replaced by a very fine slit to cause the whole slit opening to be used by the suggested reverse current following the wall. The width of the slit, which was made with great precision, was reduced by stages to 0.14 micron, but no change in the character of the phenomenon was observed.

Experiments with slits brought out the important fact that the effect is thermodynamically reversible. The thermally induced rotation of the spider (cf. Fig 2) in a liquid which, being super-fluid, causes no frictional loss, provides a mechanism which has the utmost possible coefficient of efficiency.

When helium II flows through a capillary from a higher level to a lower (Fig 3) the liquid at the lower level is found to be cooler than that at the higher. If this effect remains reversible however low the temperature, then by forcing liquid helium through capillaries and repeating the process a sufficient number of times we should have a method of getting as near as we might wish to absolute zero. Employing this method, Kapitza was able, just before the War, to obtain a reduction in temperature of 0.4° and he is now proposing to proceed with these experiments. The normal method of cooling, which depends upon the de-magnetization of para-magnetic salts, has both theoretical and practical limits to its further

usefulness, but there is no reason to suppose that the flow method has any limits whatever.

When the slit experiments appeared to dispose of the film theory, the flow phenomena (Figs 1 and 2) appeared utterly mysterious. A theory which appears at first sight to be incompatible with normal physical thought has been evolved to explain them. Its first rough outlines were sketched by Tisza in 1938³, but its scientific development is due to the Soviet physicist, L. Landau⁴. According to this theory, at temperatures below the λ -point liquid helium is a mixture of two liquids, one of which is a normal liquid and the other a liquid characterized thermodynamically by zero entropy and physically by the absence of viscosity. Just above 2.19° K the liquid is entirely in the normal state. As the temperature is lowered, super-fluid helium starts to appear, and its concentration increases progressively and that of ordinary helium decreases until at absolute zero the whole liquid, so it is supposed, has zero entropy and no viscosity. This picture is adequate to explain the flow and the thermohydrodynamical phenomena referred to above. In the neck of the flask (Fig 1) there can exist simultaneously currents of the same liquid flowing in opposite directions. The current flowing into the flask will not be affected by friction in its passage through the stream of outgoing helium, and when it reaches the heater it will be transformed into a normal liquid. The vane is thus capable of detecting the normal liquid but not the super-fluid helium.

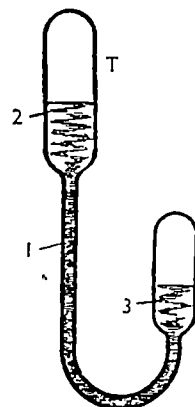


Fig 3

The mechanism of the conduction of heat is to be understood as an abnormal type of convection process which arises from the fact that to bring helium from the state of zero entropy into the normal state a quantity of heat must be expended. A rough analogy may be drawn with the contrary streams of cloaked and uncloaked people which can be imagined as moving along the passage-way to the cloak-room of a theatre. Those that are dressed for going out will represent the normal atoms of helium, which have received the energy they require from the heater (the cloak-room), and those that are uncloaked will represent the super-fluid helium atoms. Unfortunately, the analogy is far from complete, seeing that the atoms of helium in the state of zero entropy pass by their fellows who are in the normal state without any interaction, while those people who have not yet obtained their cloaks could not manage in any circumstances to keep moving through the crowd without frictional resistance.

The theory explains also why the leakage of helium through a narrow opening produces a temperature difference. Helium in the super-fluid state passes through the opening more easily than helium in the normal state. Thus there occurs a peculiar type of filtration. In the liquid which has passed through there is a greater concentration of super-fluid helium, and this corresponds with such a concentration as would presume the attainment of a certain lower temperature.

In many ways experimental work, quantitative as well as qualitative, is in agreement with the theory. Some phenomena are unexplained as yet. The theory indicates that there should be simultaneously two different speeds of sound in liquid helium. There is at present no proof of this experimentally, and, moreover, the theory does not account for the critical speed which is actually observed. Further work on the elucidation of the strange phenomena of helium II is likely to prove of considerable interest.

G. STANLEY SMITH

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³ Tisza, L., *Nature*, 141, 913 (1938).

⁴ Landau, L., *Zhur Eksper Teoret Fiziki*, 11, No. 1 (1941), *Phys. Rev.*, 60, 356 (1941).

antigenic specificity of different structural components of organs was proved, for example, in the case of the central nervous system. Also, it was demonstrated that the serum of rabbits may be caused to yield a positive Wassermann reaction by injecting the animals with a mixture of alcoholic extract of rabbit's tissue along with a foreign protein such as pig's serum, the latter being necessary to act as a 'carrier' on the analogy of Lansteiner's observations. Further researches illustrated strikingly how an antigen might be 'masked' in tissues or might fail to develop antibodies owing to the 'competition' of another antigen present along with it. *Inter alia* it was shown that an animal might come to produce antibodies to tissue constituents of its own species. The implications of those attractive observations in connexion with pathology have not yet been fully explored.

The distribution and properties of the antigens associated with the human blood groups were also extensively examined by Sachs, and his communication to the Royal Academy of Medicine in Ireland in 1939 (*Irish J. Med. Sci.*, April 1940) is a most comprehensive and readable account of knowledge on the subject up to that date.

Sachs was a man of genial outlook whose appreciation of the work of others was exercised without respect of academic or racial distinction.

C. H. BROWNING

OBITUARIES

Prof. Hans Sachs

PROF. HANS SACHS died in Dublin on March 23, with him ends the direct line of great serologists which arose under P. Ehrlich. Sachs was born in Kattowitz, Upper Silesia, in 1877. After completing his medical training he went in 1900 to the Institut für Experimentelle Therapie at Frankfurt-on-Main, where he soon proved to be a most able worker on problems of serum-haemolysis and allied studies.

When Ehrlich's chief interest shifted to cancer research and chemotherapy Sachs continued in his original field of investigation, of which he soon was the acknowledged authority. He became professor and head of the Department of Experimental Biology at the Frankfurt Institute, of which, after Ehrlich's death, he was for a time deputy director. In 1920 he went to the University of Heidelberg as professor of immunology and serology and director of the scientific department of the Institute for Experimental Cancer Research. The wide esteem in which he was held was manifested in the work entrusted to him on the serodiagnosis of syphilis for the League of Nations' Commission.

In 1908 Sachs was one of four who founded and edited the *Zeitschrift für Immunitätsforschung*. His association with this journal, now in its eighty-sixth volume, was terminated by State policy in 1935, and he also ceased to hold his post at Heidelberg. Then the Irish Medical Research Council and the hospitality of Trinity College, Dublin, enabled him to continue his work in the School of Pathology there. In addition to valuable contributions of a practical nature—the Sachs-Georgi reaction is known throughout the world as one of the first simple and reliable flocculation tests for the diagnosis of syphilis—he and his fellow-workers carried out a long series of important investigations on the antigenic properties and specificity of tissue constituents, especially those which can be extracted by alcohol (lipoids). The work appeared mainly in the *Zeitschrift für Immunitätsforschung*. The

Miss Phyllis Kelway

THE death of Phyllis Kelway on April 14 at the comparatively early age of thirty-nine comes as a shock to those who knew her as one of the small band of naturalists interested in British mammals, in particular the smaller species, such as the mice, voles and shrews. It was her probably unique distinction to have bred that smallest of living mammals, the lesser or pigmy shrew, *Sorex minutus*, in confinement, also that tiny mammal, the harvest mouse, *Micromys minutus*. She kept and studied most of the British mammals, having marked success with that delightful but difficult species, the red squirrel, *Sciurus vulgaris leucourus*, her pets "Jennifer" and "John" mating and bringing up a litter of young ones. It is noteworthy that Miss Kelway failed to get the red squirrel and the grey squirrel to take any interest in one another, her experiments supporting the view that they never fraternize, still less hybridize.

Miss Kelway wrote several books setting forth her observations and experiences, "Swift Movement in the Trees" telling of squirrels, shrews and many other creatures, while in her last book, "The Ark", she dealt with another theme, the difficulties of a smallholder in war-time. She illustrated her writings both in the Press and in book form with photographs from her own camera, for she was a skilled and charming photographer. She was born in Somerset, but lived in Yorkshire, at Almondbury near Huddersfield.

FRANCES PITT

WE regret to announce the following deaths:

Dr. K. J. W. Craik, director of the Applied Psychology Unit of the Medical Research Council, on May 7, aged thirty-one.

Prof. Thomas J. Nolan, professor of chemistry since 1932 at University College, Dublin, on March 12, aged fifty-six.

NEWS and VIEWS

Geological Survey of Great Britain

Sir Edward Bailey, F.R.S

SIR EDWARD BATTERSBY BAILEY, who has just retired from the directorship of the Geological Survey Museum, joined the Scottish Branch of the Survey in 1902, at the age of twenty-one, and rapidly established an international reputation as a leading authority on the tectonics of the Scottish Highlands. He served with distinction throughout the War of 1914-18 and after the conclusion of hostilities became in 1919 district geologist in charge of the West Highland and Ayrshire work. An outstanding achievement during his tenure of this post should be mentioned, namely, the preparation of the classic memoir on the Tertiary igneous rocks of Mull (1924). In 1929 he resigned, on his appointment to the chair of geology at the University of Glasgow, but he returned to the Survey as director in 1937.

The short period from 1937 to the outbreak of the present War saw the inception of comprehensive plans for field-work to accelerate the mapping of districts urgently requiring revision. Sir Edward's directorship will, however, be remembered chiefly for the notable part he and his colleagues played in carrying the war effort, especially during the early critical years. When the events of 1940-41 made it necessary to develop the country's mineral resources to the utmost, he threw himself with characteristic energy into the task of carrying out an immediate investigation into the available supplies of such essential raw materials as iron ores, bauxite, limestone, lead, zinc, tin and copper ores, feldspar, and silica sands suitable for optical glass. He

extended and amplified the Survey's investigations into underground water supplies throughout Great Britain, and carried through the preparation of a large series of war-time pamphlets in which the results of Survey work were made easily and rapidly accessible. In addition, Sir Edward and his staff were able to give assistance in many engineering projects directly connected with the war effort, such as the siting of aerodromes, camps and emergency hospitals, the provision of underground storage, and selection of localities suitable for opencast coal production. He has also collaborated closely with Government departments concerned with post-war reconstruction and industrial development. All these varied activities he has pursued with energy and success, and the results may be said to have demonstrated anew the importance of the part which geology and geological research can play not only in the emergency of a country at war, but also in the no less urgent problems of the years of peace ahead. Dr F. P. McLintock, deputy director, is at present in charge of the work of the Geological Survey and Museum.

Howard Florey, F.R.S : Lister Medallist

THE Lister Medal for 1945 of the Royal College of Surgeons of England, which is awarded in recognition of distinguished contributions to surgical science, has been granted to Sir Howard Florey, professor of physiology in the University of Oxford, for the outstanding importance to surgical science of his work on penicillin and its application. He will deliver the Lister Memorial Lecture later in 1945. This is the first occasion of the award, which is made by a committee representative of the Royal Society, the

Royal College of Surgeons of England, the Royal College of Surgeons in Ireland, the University of Edinburgh and the University of Glasgow.

Treatment of Leprosy

A NEW treatment of leprosy reported from Madagascar (*Brit. Med. J.*, 338, March 10, 1945, and *Lancet*, 357, March 17, 1945) suggests that it is, in some respects, a considerable advance in the fight against this ancient and terrible scourge of mankind. Drs Boiteau and Grimes extracted, so long ago as 1937, a new glucoside from the umbelliferous plant *Hydrocotyle asiatica*, which gave encouraging results when it was tried for the treatment of leprosy, but it was too toxic. In 1938 Bontemps, working at Antananarivo, isolated another new glucoside which he called 'asiaticoside', and this was not only active against leprosy but was also much less toxic. It was insoluble in water, slightly soluble in alcohol and very soluble in pyridine. Later Boiteau obtained a solution of it suitable for injection, and Devanne and Razafimahery have studied its chemical constitution. Boiteau and Grimes think that it acts by dissolving the waxy covering of *B. lepræ*, so that the bacillus then becomes very fragile and may easily be destroyed by the tissues or by some other drug. The results of injections of the solution prepared by Boiteau are reported as being remarkable. Leprosy nodules are broken down, diffuse infiltrations disappear, perforating ulcers and lesions on the fingers heal and, most remarkable of all, eye lesions are rapidly cured if treatment is given before the posterior chamber of the eye is involved. If fuller reports of trials on a larger number of patients substantiate these claims, and if asiaticoside can be prepared in sufficient quantity, mankind will owe a great debt of gratitude to the discoverers of this remedy. If the view that it acts by dissolving the waxy coating of the bacillus is correct, it is not inconceivable that it may show the way towards the control of infections with other bacilli which have a waxy envelope, such as the bacillus of tuberculosis.

Historic St. Andrews and its University

THE year 1754 gave promise of being an important one in the annals of Scotland, for it saw steps taken to found the Edinburgh Society for the Encouragement of Arts, Sciences, Manufactures and Agriculture. Within a decade, however, the Society had metamorphosed into a Society for Promoting the Reading and Speaking of the English in Scotland, which led to a fate justly deserved. But according to Prof. John Read, in the second edition of his pamphlet "Historic St. Andrews and its University" (W. C. Henderson and Sons, Ltd., St. Andrews, 1945), 1754 also saw a more enduring and certainly much more influential society formed by twenty-two "Noblemen and Gentlemen, being admirers of the ancient and healthful exercise of the Golf", namely, the Royal and Ancient Golf Club—legislative authority of the game. By that time, however, the University of St. Andrews, junior only to Oxford and Cambridge in Great Britain, was more than three centuries old, with a tradition and setting that make St. Andrews "at once the Canterbury and the Oxford (or Cambridge) of Scotland".

It is not surprising, then, that we learn from Prof. Read that the tomb of the founder of St. Salvator's College, erected in 1458, is "probably the finest specimen of mediæval work in Britain" and that the silver gilt College and Faculty maces are "older than

even the oldest of the English maces", and that the Natural Philosophy (*anglicé* Physics) Department houses the finest extant Elizabethan scientific instrument, Humphrey Cole's great astrolabe (1575). At their best, Scottish professors of chemistry have been men of erudition, and Prof Read, present director of the Chemical Research Laboratories at St Andrews, maintains that valuable, if passing, tradition. Not a few who have never heard of terpenes may be inspired by his pamphlet, if they are fortunate enough to see it, to make a post-war pilgrimage to the "little city, worn and grey".

Relation of Meteors to Short-Wave Radio 'Whistles'

A NOVEL explanation of some peculiar whistles audible under certain conditions in short-wave radio receivers is put forward by S R Khastgir (*Indian J Phys*, 17, 239, 1943). Weak short-lived whistles of rapidly descending pitch have been noticed at the Delhi receiving station of All-India Radio when a receiver is tuned to the carrier wave of the nearby short-wave transmitters. Two possible explanations are offered, in both of which the phenomenon is attributed to the entrance of a meteor into the earth's upper atmosphere. In the first, the meteor is supposed to produce a rapidly moving mass of ionized air at its head. This local Heaviside layer scatters the incident radiation from the transmitter, the rapid descent causing a Doppler change in the frequency of the scattered waves. These then interfere with the ground waves reaching the receiver, and an audible beat note is produced. As the descent is retarded by atmospheric resistance the Doppler shift lessens, and the pitch of the whistle drops. On a carrier wave of 7 Mc/s a whistle starting at 3,000 c/s would be caused by a meteor with a maximum velocity component of 64 km/s towards the receiver—not an unreasonable value.

The second hypothesis supposes that the retardation of the meteor in the ionosphere produces, in some way, an electrical impulse similar to audio-frequency static. The Fourier components of this impulse, transmitted at different velocities through the ionosphere, will reach its lower fringe in succession (the shorter waves first) and will modulate the scattered carrier waves at a frequency which is a function of time. A receiver tuned to the carrier will thus reproduce a whistle descending in pitch at a rate which should depend on the ionization. Test experiments will no doubt distinguish between these hypotheses, but there seems no doubt about the observed facts—that the whistles frequently coincide with observed meteors, and that they occur most often in the early morning, when the number of meteors is a maximum. They are thus likely to be of fundamentally meteoric origin whatever may be the details of their production.

Polish Science and Learning

THE fourth number of *Polish Science and Learning*, the series of booklets edited by the Association of Polish University Professors and Lecturers in Great Britain, is a specially educational issue. Several preliminary articles are contributed by American and British writers. Dr Maxwell Garnett's theme is English education in relation to international problems. The makers of the Paris Peace, a quarter of a century ago, he says, took no account of education and little of economics, but relied on political pacts, unsupported by the thoughts and feelings of average citizens. All

will agree that we must do better this time, though all may not agree with the details of Dr Garnett's way of doing it. Prof Powicke's article, though written for a different occasion, is wisely included because of its explanation of Oxford's peculiar contribution to English life, the claims of mere learning being subordinated to the service which learning can render to English society. We may be amateurs but we are not pedants.

The main body of the booklet, contributed by Polish authorities, makes sad reading, because every aspect of education is necessarily treated from a pre-war and the post-war points of view. In other words, the writers describe what has been ruthlessly and completely destroyed, and proceed to describe the immense task of reconstruction which faces Poland of the future. No aspect of education seems to have been omitted by the editorial committee. Among the subjects of the articles are elementary schools, secondary education, the training of teachers, technical schools, university education, scientific and technical research, books and libraries, adult education, art education and physical education. The concluding 'Chronicle' is a useful addition to a very comprehensive report on the educational situation in Poland.

Blind Workers in Industry

CERTAIN occupations such as basket-making, mangle and telephone-exchange operations have been assumed to be almost the only possibilities for the blind, and the normal factory environment has been dismissed as unsuitable. Since the need for labour during the War, many firms have experimented with a few blind workers, and a study of 215 blind workers employed in different firms has been made by K G Fenelon, of the University of Manchester. Industries included, among others, general electrical engineering, aircraft, metal ware, wood-work. 104 of the workers were trained by the firms themselves on the factory premises, 53 by the Institute for the Blind, 2 by an education committee, 8 their own homes, while 48 had no specific training but obtained their experience on the job. The firms who have experimented with blind workers report that, while some fall short of the production obtained by the fully sighted workers, yet some are quite up to normal standards and also that they are no more liable to accidents than other workers. Some involve the provision of special aids, but others can be undertaken by them with the ordinary machine. They are particularly successful in work where delicacy of touch compensates for inability to see. It is therefore important that the jobs selected for them should be suited to their particular abilities. Their concentration on the job in hand is good, and they are in general keen and industrious. One difficulty is that they are apt to get irritated by any hoarding of material. It seems clear even from this limited survey that there is a case for a comprehensive research into the possibilities for the blind. Apart from their potential value as workers, it would be an advantage to them to form part of an ordinary community.

Rickettsiasis in Brazil

THE January issue of the *Boletín de la Oficina Sanitaria Pan-Americana* contains an interesting review of this subject by Dr Otávio Magalhães, member of the Pan-American Typhus Committee.

st of the information concerns the State of Minas Geraes, Brazil, where Rocky Mountain spotted fever apparently existed for some time. There are four usual forms of the disease: inapparent, mild, benign and fulminating. It seems that there is only one virus, but probably there are various strains which may be differentiated by proper tests. The demiological nature of the infection in some parts of Minas Geraes is quite different from that of Rocky Mountain spotted fever in the United States.

Tables of Bessel Functions

THE Committee on Mathematical Tables of the National Research Council was advised that there was a great need for a modern "Guide to Tables of Bessel Functions", as there is scarcely a single field of applied mathematics in which these tables are not used. After more than a year of preparation, this "Guide" was compiled by Prof. H. Bateman and R. C. Archibald, using material on which the former had been working for many years. It has been published as a special number, occupying 104 pages, of the journal *Mathematical Tables and other Aids to Computation* (1, 205, 1944, Washington, D.C.: National Research Council. 175 p. 10s). There are two parts, one in which tables and graphs are listed with their authors, and another consisting of an alphabetical bibliography of the authors. In some places there are important formulae and explanations of how to use them. The notation has been chosen so as to agree so far as possible with that used by English authors. In addition to giving references to all published tables of Bessel functions, the authors endeavoured to add details of every known unpublished table, but unfortunately the comprehensive Liverpool "Index of Mathematical Tables" prepared by A. Fletcher, J. C. P. Miller and Rosenhead was not available, even in proof, until it was too late to give more than a cursory reference, so it was then found that the "Index" referred to more than thirty manuscript tables unknown to the reader. The second edition of Watson's "Bessel Functions" appeared too late to be mentioned. A notable feature of the "Guide" is the information concerning all known errors in the tables mentioned. A number of errata lists appear in print for the first time.

Radiant, Dielectric and Eddy-Current Heating

A PAPER on the place of radiant, dielectric and eddy-current heating in the process-heating field was read recently in London before the Institution of Electrical Engineers by Messrs. L. J. C. Connell, O. W. Humphreys and J. L. Rycroft, in which the authors maintain that if the fullest advantage is to be gained in the rapid developments which have taken place in connexion with radiant and high-frequency methods of heating, care must be exercised in the selection of the applications for which they are recommended. Although many processes can be carried out more effectively by the new methods, there is still a very real place for contact and convective heating. The purpose of the paper is to facilitate this selection. The paper first reviews the various methods of heating, indicating the physical laws and practical considerations by which they are governed and the types of heating which may be obtained. The types of application for which each process is best suited

are then classified in terms of their technical requirements. Finally, several applications are considered in some detail, and it is shown that processes having superficial similarity may nevertheless possess features, not at first apparent, which are of sufficient importance to warrant the use of different methods of heating.

The Earthquake at San Juan, January 15, 1944

HORACIO J. HARRINGTON, professor of geology at the University of Buenos Aires, has described some of the effects of this earthquake ("El Sismo de San Juan del 15 de enero de 1944", *Cronica Investigacion*, Jan 1945). The shock occurred at 19h 46m 29s without any previous warning and attained a maximum intensity in a few seconds, ending suddenly about 15 seconds after the first shock. The first shock was from below upwards, and in a few seconds afterwards a new shock took place in a horizontal direction and of an undulatory nature, from west to east. When the tremors had ceased, some 90 per cent of the buildings in San Juan had been totally or partially destroyed. The depth of focus was 14 km, with a probable error of 3 km, and the epicentre included the zone extending north from San Juan to Chimbass and Albardón. The intensity of the San Juan earthquake was IX on Sieberg's scale, and so was not excessive, nevertheless the destruction was very much greater than would have been expected. Out of a total population of seventy to eighty thousand, about eight thousand were killed and twelve thousand injured, the disproportion between the intensity of the earthquake and the destruction effected is obvious. The loss of life in the San Juan earthquake was due to the buildings being made with unbaked bricks of clay, these should be avoided in reconstruction. In addition, many of the cities of the country are built at the foot of high mountain ranges, and zones of fracture render their existence more or less precarious.

Announcements

SIR JACK DRUMMOND, chief scientific adviser to the Ministry of Food, has been appointed to the post of director in charge of the whole of the scientific research of Boots Pure Drug Co., Ltd. Sir Jack Drummond has resigned the chair of biochemistry at University College, London, which he has held since 1922, but he will not take up his new appointment until the food situation has improved.

THE Council of the University of Sheffield has accepted a gift of £1,000 from Dr S. B. Bagley, chairman of the Glass Delegation, to provide a fund for research purposes within the Department of Glass Technology.

The Medical Research Council has offered to establish a Biochemical Research Unit in the University under the direction of the professor of biochemistry, and the University Council has accepted the offer.

The Council has made the following appointments: Dr B. M. Lang, at present lecturer in charge of the Department of Philosophy, to the newly instituted chair of philosophy; Major F. W. Shotton, to the chair of geology in succession to Prof. W. G. Fearnside, on the retirement of the latter; Mr A. M. Woodward, at present lecturer in charge of the Department of Ancient History, to be reader in ancient history and archaeology, and head of the Department of Ancient History.

LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications.

Application of the Chemiluminescence Test for Hæmatin to Plant Tissues

CYTOCHROMES and other catalysts capable of yielding hæmatin are widely distributed in living tissues. It is, therefore, possible *a priori* that many tissues will give a positive reaction in the luminescence test with *o*-amino phthalic acid cyclic hydrazide ('luminol') when treated in some way which will lead to the formation of hæmatin. However, in the forensic application of the test it has generally been found that vegetable matter, either fresh or rotting, gives a negative reaction¹.

The confirmation by Keilin and Wang² of the hæmoprotein nature of the red pigment of the root nodules of leguminous plants, and their identification of this pigment as a hæmoglobin, prompted an examination of the chemiluminescence reaction of nodular tissue.

The reagent was made by dissolving 100 mgm luminol and 5.0 gm Na_2CO_3 in 100 ml water and adding 20 ml. H_2O_2 (10 vol approx.) just before use. The very faint inherent luminescence of this solution was not regarded as sufficient to interfere with the reactions now described.

Solutions for test were then prepared as follows (A) 4 ml water + 1 ml 5 per cent NaOH (B) 50 mgm fresh root nodules (*Trifolium hybridum*) ground with 1 ml 5 per cent NaOH and diluted with 4 ml water (C) 50 mgm fresh leaf tissue, from the same plant, ground with 1 ml 5 per cent NaOH and diluted with 4 ml water (D) 50 mgm fresh nodules, also from the same plant, dried in the steam oven and then extracted by grinding with 5 ml. water.

3 ml portions of these test solutions were then added in the dark to 5 ml portions of the reagent in test tubes. The reactions were as follows (A) No reaction. On adding extra NaOH solution, no change (B) An intense and vivid whitish-blue luminescence. This faded gradually, but addition of extra alkali gave a perceptible brightening of the fading luminescence (C) A faint increase over the inherent luminosity of the reagent, the colour being altered somewhat by the presence of chlorophyll derivatives. Little, if any, change on adding extra alkali (D) A strongly positive reaction, similar to that given by solution (B) but not nearly so intense. On adding extra 5 per cent NaOH to the fading solution, the luminescence increased so as to become much stronger than initially. Fading did not seem so rapid as in the case of solution (B).

The observations were then extended to solutions of (E) 50 mgm stem tissue and (F) 50 mgm root tissue, also from *T. hybridum*, and of (G) 50 mgm potato tuber, each being ground with 1 ml 5 per cent NaOH and diluted with 4 ml water. These solutions reacted to the test in the same way as the leaf tissue solution (C), except that secondary addition of alkali decreased luminescence. A water extract of fresh nodules (H) behaves in the same way as the water extract of dried nodules (D).

These observations are consistent with the hypothesis that the most powerfully reacting compound in the plant tissues examined is the hæmoglobin of the root nodules, and that other compounds capable

of yielding hæmatin are present in concentrations too minute to afford amounts of hæmatin capable of giving a strong reaction under the specified conditions. The results of tests (D) and (H) are consistent with the hypothesis that hæmatin forms during grinding with water or drying is too slow to give a really intense reaction, but that subsequent addition of alkali splits off the prosthetic group of the hæmoglobin from the protein moiety and leads to the production of hæmatin so as to give a stronger reaction than initially.

It is possible that the chemiluminescence test may be of use as a rapid sorting test for locating in plant tissues unusual concentrations of substances capable of yielding hæmatin, or for the demonstration of hæmoglobin in leguminous root nodules where adequate spectroscopic equipment is not available.

I wish to thank Prof D. C. Harrison for his advice on various possible interpretations of the reaction.

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March 13

¹ McGrath, J., *Brit. Med. J.*, 156 (1942).

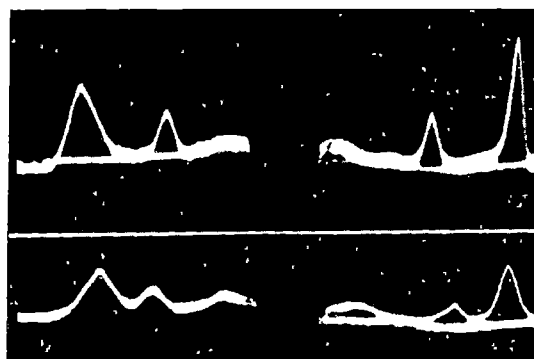
² Keilin, D., and Wang, Y. L., *Nature*, 155, 227 (1945).

Electrophoretic and Enzymatic Fractionation of Casein from Human Milk

SOME years ago I examined electrophoretically casein from cow's milk. It was established that the protein is not homogeneous¹. The electrophoretic diagram showed three different boundaries which were assumed to correspond to three casein fractions α -, β - and γ -casein. The fastest moving of the α -fraction, was isolated, and on analysis nitrogen/phosphorus ratio was found to be higher than that of total casein.

It has been considered worth while, especially in view of the importance of the organically bound phosphorus for breast-fed babies, also to examine human milk casein for the existence of electrophoretically separable fractions and their phosphorus content.

As may be seen from the accompanying record the electrophoretic pattern of human milk casein is similar to that of casein from cow's milk. The



Descending ← → Ascending
ELECTROPHORETIC PATTERNS OF CASEIN FROM COW'S MILK (ABOVE) AND HUMAN MILK (BELOW), pH 7.62 (PHOSPHATE BUFFER IONIC STRENGTH 0.15 (PHOSPHATE 0.10 + SODIUM CHLORIDE 0.05)). THE PHOTOGRAPHS WERE TAKEN AFTER MIGRATION FOR 105 MIN (ABOVE) AND 165 MIN (BELOW) AT 5.70 VOLTS/CM. PROTEIN CONCENTRATION 1 PER CENT.

peaks are shown. The two which move quickest no doubt represent two definite fractions of the casein. The third peak might, at least in part, be due to a δ -effect. The same may also be true of the γ -fraction of cows' casein. As is shown in Table 1, its mobility is very low in different buffers. The α -casein from human milk also shows a higher phosphorus/nitrogen ratio than the original casein (Table 2). Thus, casein from human and from cow's milk is similar in this respect. However, the difference in phosphorus content between α -casein and the original casein is more pronounced for human milk casein.

TABLE 1 ELECTROPHORETIC MOBILITIES, IN $\text{cm}^2 \text{V}^{-1} \text{sec}^{-1} \times 10^5$, OF THE FRACTIONS OF CASEIN FROM HUMAN MILK AT DIFFERENT pH (PHOSPHATE BUFFER) IONIC STRENGTH 0.1 TEMPERATURE 0.0°

pH	α -casein	β -casein	γ -casein (%)
6.4	-5.2	-3.7	+0.9
7.40	-5.0	—	+0.7
7.10	-4.7	-3.2	+0.9
7.72	-4.7	-2.9	+0.0
7.46	-4.1	-2.4	+0.0
7.92	-3.3	-1.8	+0.0
7.64	-3.0	-1.5	+0.0
7.42	-2.8	-0.9	—

TABLE 2 ANALYTICAL DATA FOR CASEIN FRACTIONS

	% N	% P
Casein 1	15.14	0.46
Casein 2	15.11	0.47
α -casein 1	—	0.95
β -casein 2	—	0.87

Trypsin- and pepsin-resistant fractions of casein from cow's milk) with relatively high phosphorus content have been isolated by several authors.² In order to find out whether this ferment-resistant fraction of casein is identical with, or a part of, the δ -casein (which might be expected from the high phosphorus content of the ferment-resistant fraction) the progress of pepsin and trypsin digestion on casein from human and cow's milk respectively has been followed electrophoretically. It has been found that the α -component disappeared even during pepsin hydrolysis, and no demonstrable component of higher mobility was formed. Following the method of repARATION of Damodaran and Ramachandran, it has also been possible to prepare enzyme-resistant phosphopeptide from human milk casein. In the sodium salt of this, the phosphorus content was 28 per cent and the nitrogen content 6.57 per cent.

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Mellander, *Biochem. Z.*, 240 (1939)

See, for example, Damodaran, M., and Ramachandran, B. V., *Biochem. J.*, 35, 122 (1941)

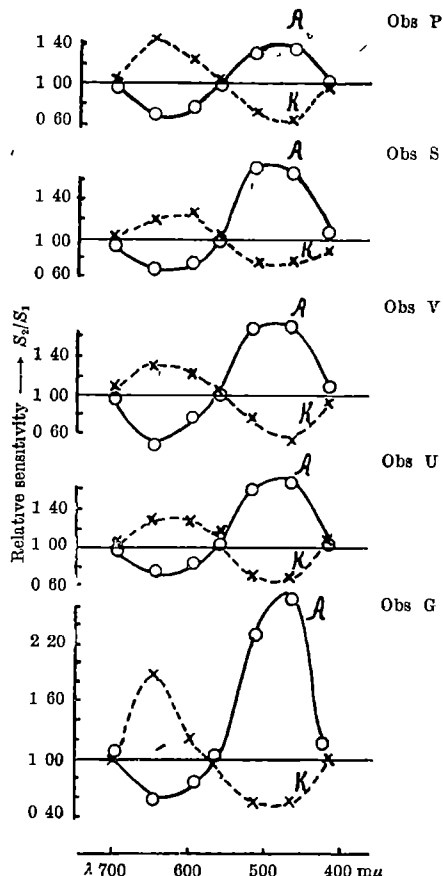
Electrotonus in Colour Vision

DURING the past year, we have studied the influence of a weak constant electrical current upon the foveal (colour) sensitivity of the human eye. The foveal sensitivity was measured in respect of monochromatic lights of different wave-lengths. Two silver electrodes were used. The indifferent one was put on the observer's hand, the second—the different one—being applied to the contralateral eyeball of the observer or (in some control series) on his temple near the lateral angle of the eyelids. The current used always had a strength of 0.2 mA. Our experiments, in which we determined the threshold

values for foveal sensitivity, were carried out during 50–60 minutes of dark adaptation. At about the thirtieth minute of dark adaptation, when the foveal sensitivity reached its maximal stationary level, we switched on the current and allowed it to remain on for 4–5 minutes. During that period of electrical stimulation we determined the thresholds of the foveal sensitivity two or three times.

The sensitivity was calculated as the reciprocal of the transparency of the corresponding part of the absorbing photo-wedge used to alter the intensity of the monochromatic light stimuli. The sensitivity changes under the influence of applied constant current were indicated by the ratio S_2/S_1 , where S_2 is the foveal (colour) sensitivity of the eye found at the third minute of electrical stimulation, and S_1 is the same sensitivity determined just before the current was switched on. Five persons with normal colour vision took part in our experiments as observers. The data obtained are plotted on the accompanying graph. The values of S_2/S_1 are shown as ordinates, the wave-length of stimulating light, in $\text{m}\mu$, as abscissa. A -curves relate to the readings made when the positive electrode was in contact with the eyeball (anoelectrotonus), the K -curves indicate the changes in sensitivity found in the case when the negative electrode was on the eye (cathelectrotonus).

From the graphs, it can be seen that under the influence of anoelectrotonus and cathelectrotonus the changes in foveal (colour) sensitivity of the eye are of quite an opposite character. In the case of anoelectrotonus, the sensitivity for the blue-green rays of the spectrum heightens, while the sensitivity for the orange-red rays of the spectrum diminishes. In



the case of cathelectrotonus, the sensitivity for orange-red rays is heightened and for the blue-green rays lowered. In both cases there are three regions in the spectrum which have shown no changes at all in response to the electrotonic stimulation used in our experiments. These regions are the two ends of the spectrum, red and violet, and the zone of yellow near 570 m μ .

After switching off the stimulating current we observed, as a rule, changes of foveal sensitivity, which were the inverse of those found while the stimulating current was on. After four or five minutes of electrotonic stimulation, the sensitivity of the eye continued to be different for about twenty to thirty minutes.

The effects described above can be explained on the basis of the well-known ionic changes in the living tissues caused by a constant current, namely, the relative heightening of the potassium ion concentration near the negative pole and the relative heightening of the calcium ion concentration at the positive pole. It is also well known that potassium and calcium are in many physiological respects as antagonistic. At the same time, the action of potassium ions resembles the stimulation of the parasympathetic part of the autonomic nervous system, whereas the action of the calcium ions is like stimulation of the sympathetic nerve¹. Thus, our experimental observations relating to the dependence of our colour vision on electrotonus may also suggest its dependence on the autonomic nervous system as recently suggested by one of us².

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¹ Zondek, S. G., *Klin. Wochsft.*, No 9, 382 (1923) Tinel, J., "Le système nerveux végétatif", 813 (Paris, 1937)

² Kravkov, S. V., *Acta Medica URSS*, 2, 461 (1939) *J. Opt. Soc. Amer.*, 31, 335 (1941)

Augmentation of Thyrotrophic Activity

THE following observations were made during pilot investigations on the purification of thyrotrophin from acetone-dried ox pituitary. An aqueous alkaline (pH 9-10) extract of the dried gland (from which some inactive material had been removed by isoelectric precipitation at pH 5) was brought to pH 2 with salicylsulphonic acid. The thyrotrophic activity was divided between the precipitate and the supernatant fluid, each of which apparently contained 100-200 per cent of the original activity. This was shown in three separate experiments. The third experiment showed the least augmentation, which was unfortunate, as it was carried out to test the effects of dialysis (20 hr through collodion) on the augmenting substance. The results, at least for the supernatant fluid, suggest that the augmenting substance is dialysable, though the small augmentation observed and the few animals used in the test do not establish this statistically.

The results recorded in the accompanying table show the weight of guinea pig thyroid glands (adjusted for body-weight differences) after the injection of doses equivalent in each case to 300. mgm of the

original dried pituitary. The tests were carried out on groups of three animals according to the method of Rowlands and Parkes¹.

Expt	Wt of thyroid gland $\pm$ s.e. (mgm)		
	Original Extract	Salicylsulphonic acid	
		Supernatant	Precipitate
1	30 $\pm$ 3	61 $\pm$ 5	65 $\pm$ 9
2	30 $\pm$ 2	63 $\pm$ 10	58 $\pm$ 6
3 normal dialysed	28 $\pm$ 4	35 $\pm$ 5	27 $\pm$ 6
	28 $\pm$ 2	26 $\pm$ 3	26 $\pm$ 3

Weight of thyroid in 11 un.injected animals = 15 $\pm$ 2 mgm

We have had no opportunity of investigating this matter any further, but assume that the augmentation is caused by delayed absorption from the injection site, since such effects of contaminants have been reported for many other biologically active substances. The effect, whatever the cause, must obviously be taken into account when impure thyrotrophic extracts are assayed by methods using subcutaneous injection.

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¹ *Biochem. J.*, 28, 1829 (1934)

Structure of Wharton's Jelly

Baechich and Riddell¹ have recently discussed the nutrition and structure of Wharton's jelly of the umbilical cord. Their letter was prompted by the description by Barcroft *et al.*² of a non-vascular circulation through the cord from placenta to foetus. Baechich and Riddell compare the avascular nature of cornea, cartilage and Wharton's jelly and suggest that their nutrition must be similar, they conclude that the non-vascular circulation may contribute to the nutrition of Wharton's jelly itself. They point out that cornea, cartilage and Wharton's jelly all contain similar metachromatic substances and say "It appears justifiable to suppose that the substance responsible for the specific (metachromatic) staining reaction is either heparin, which is a mucopolysulphuric acid or a chemically allied substance because only these substances give a metachromatic staining reaction with toluidine blue".

We would like to direct attention to the work of Meyer and his colleagues^{3,4,5,6} in America, and McClean and his colleagues^{7,8} in Great Britain, who have shown that the acid polysaccharide, hyaluronic acid, is at least a major component of Wharton's jelly. This polysaccharide, which is apparently composed of equimolar parts of *N*-acetyl glucosamine and glucuronic acid³, is widely distributed as a constituent of synovial fluid⁴, cornea⁵, vitreous humour³, skin⁵, muscle¹⁰, the cumulus cells and corona radiata of the unfertilized ovum¹¹ and the capsules of certain groups of streptococci^{12,13,14}. Meyer and Chaffee state that the hyaluronic acid of the cornea and skin exists as the sulphuric acid ester. It is known that hyaluronic acid forms an insoluble complex with toluidine blue, but according to Meyer and Chaffee does not stain metachromatically whereas the sulphuric acid ester does. We would also direct attention to the exhaustive studies of Lison¹⁵ on metachromatic

ains and their reactions; he showed that meta-chromatic staining depends primarily upon the presence of sulphuric acid groups attached to compounds of sufficiently high molecular weight. We have found that, owing to its solubility, hyaluronic acid is removed from tissues during fixation by ordinary histological methods, and, in order to prevent this, it is probably necessary to use some such fixative as Carnoy's fluid. It is therefore probable that the hyaluronic acid had been removed from the specimens of umbilical cord examined by Bacsich and Riddell and that the metachromatically staining substance described by them was chondroitin sulphuric acid, which Meyer and Palmer consider is a constituent of the connective tissue of the cord.

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Bacsich and Riddell¹, in their letter of March 3, discuss the structure and nutrition of the cornea, cartilage and Wharton's jelly, suggest that the metachromatic staining of the cornea with toluidin blue may be due to heparin or some other related compound. Jorpes, Holmgren and Wilander² briefly reported that a substance prepared from cornea which had the properties of a mucoitin sulphuric acid showed only a very weak heparin activity. They thought that this activity was due to the small amount of heparin extracted from the mast cells at the limbus, and that the general metachromasia was due to the mucoitin sulphuric acid. Meyer and Chaffee³ have since isolated a mucoitin sulphuric acid from ox cornea and shown that it is the mono-sulphuric acid ester of hyaluronic acid, the sulphate-free polysaccharide which Meyer and Palmer⁴ had isolated from Wharton's jelly and vitreous humour. They found that it is present in the cornea in a concentration of at least 1.8 per cent. They failed to isolate mucoitin sulphuric acid from the sclera, which shows metachromasia.

A sample of ox cornea mucoitin sulphuric acid (ester sulphur 4.1 per cent) was very kindly tested for heparin activity for me by Dr. MacIntosh and found to be inactive. MacIntosh⁵ compared the anti-coagulant activity of various heparins and other sulphur-containing polysaccharides with their reaction with toluidin blue. He found that the two properties ran roughly parallel, mucoitin sulphuric acid having a negligible heparin activity and a colour value with toluidin blue of about 1 per cent that of the purest heparin. In spite of the relatively weak

reaction between toluidin blue and mucoitin sulphuric acid, the concentration in the cornea is ample to account for the diffuse metachromasia. A 0.003 per cent solution of ox cornea mucoitin sulphuric acid gives an easily visible purple colour with dilute toluidin blue. There seems therefore no need to invoke heparin or some unknown substance to explain the metachromatic stain of the cornea substantia propria.

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- ¹ Bacsich, P., and Riddell, W. J. B., *Nature*, **155**, 271 (1945).
² Jorpes, E., Holmgren, H., and Wilander, O., *Z. Mikro. Anat. Forsch.*, **42**, 279 (1937).
³ Meyer, K., and Chaffee, E., *Amer. J. Ophthalm.*, **23**, 1320 (1940).
⁴ Meyer, K., and Palmer, J. W., *J. Biol. Chem.*, **114**, 689 (1936).
⁵ MacIntosh, F., *Biochem. J.*, **35**, 776 (1941).

Spontaneous Transmissible Tumours in the Syrian Hamster

SINCE 1930 a large number of Syrian hamsters have been bred in the Hebrew University, mainly for work on kala-azar. All the animals originated from a single family and have been distributed to laboratories to various parts of the world. A record of spontaneous tumours in Syrian hamsters is therefore of general interest.

During the last seven years, we have noted thirteen instances of spontaneous tumours among a thousand animals, which were carefully examined since they had been used for experimental work on leprosy. In one case a polymorph sarcoma was found. This tumour has been passaged twenty-five times during the last three years by grafts, by inoculation of macerated tumour and by heart blood. It metastasizes in lymphatic glands, liver, spleen, kidney, stomach, intestines, muscles, testes and ovary. It is not transmissible by filtrates of macerated tissue. Inoculated animals survived up to five months in the first ten passages and up to two months in subsequent ones.

Another polymorph sarcoma, also freely metastasizing, was observed, and thirteen passages have been noted in sixteen months. Inoculated animals survive up to three months.

A carcinoma was discovered embedded in pancreatic tissue and was found to be readily transmissible and metastasizing in lymphatic glands, kidneys, testes, spleen, pancreas, liver and lungs. Six passages have been obtained during twenty months. The majority of inoculated animals survived up to five months but a few lived up to one year.

Cortical hypernephromas (in the adrenals) have been observed in ten animals during the last seven years; but only two have proved transmissible by subcutaneous and intraperitoneal grafts. From one tumour five passages have been obtained in four years, and from another two passages in eighteen months. Minute metastases were found in the pancreas, lymphatic glands and suprarenals but longevity was not affected.

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A Hitherto Undescribed form of Adult Axis in the Genus *Batrachospermum*

THE genus *Batrachospermum* has always attracted interest as one of the few freshwater members of the Florideae and on account of its distinctive appearance. Notwithstanding a general familiarity with the external form and early development of *Batrachospermum*, it has not been recognized previously that the old axes of some species may appear 'solid' in transverse section, either all or almost all trace of the primary central filament of cells being lost. Such a condition has been found to exist in three species of this genus (Fig. 1), and there is no reason for doubting that subsequent investigation may show it to occur in other non-ephemeral species. The three species mentioned have not been identified with certainty as comparison with type specimens has been impossible in present circumstances, but two undoubtedly belong to the Helminthoidea section of the genus. Only male plants of the third species, the one here illustrated, have been seen and hence its affinity remains in doubt.

Detailed study of one of the three species has shown the steps by which this 'solid' structure is attained, and these are to be described fully in a subsequent publication. Briefly, they are as follows: branches from the filaments which corticate the central filament from quite an early age actually penetrate the cells of this central filament in a manner similar to a parasitic fungus penetrating the host. Once inside, these invading filaments grow, branch and ultimately fill the upper part of the cell completely, as is shown in Fig. 1. In Fig. 2, which is a photograph of the same cell at a slightly lower level, the cell is almost full of invading filaments cut transversely. There may be so complete a disintegration of the cell wall at the upper end that all trace of it is lost. The diameter of the basal end of the cell is always much greater than at the apical end and there the wall may remain intact or else considerable remnants are to be seen as well as a space representing the area of the original lumen of the cell, traversed by a few filaments (Fig. 3). Filaments invading the central cells may pass from cell to cell in a longitudinal direction or they may enter at one side and directly pass out at the other side.

This secondary development in the centre of the axis is usually accompanied by a proportionately greater production of secondary branches of limited growth, resulting in an evenly cylindrical thallus. These axes may be stronger than the primary

ones and hence may be of biological importance to the species.

The similarity of the general appearance of the secondary condition of the uniaxial type to the primary condition of the multiaxial type of construction in the Florideae, such as is found in *Nemalion*, is so obvious that it needs no stressing: but the fundamental ontogenetic difference between the two types remains.

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Insect Transmission of the 'Swollen-Shoot' Virus in West African Cacao

DURING 1943-44, exploratory experiments were carried out at Tafo, Gold Coast Colony, to determine which insects might prove to be vectors of the well-known 'swollen-shoot' virus disease which is causing widespread destruction of native-grown cacao (*Theobroma Cacao* L.) in certain parts of West Africa, notably in the eastern province of the Gold Coast. Four recognizable 'strains' of the virus were tested separately, in the experiments, namely:

I. Virulent strain. Characterized in the infected plant by the development of pronounced swelling in the recent ligneous growth; by a typical mosaic in the foliage especially noticeable in the new leaves (flush) appearing after infection; and death within a period rarely exceeding eight months in the case of plants infected when less than two years old.

II. Non-virulent strain. Swellings only, or at most an indeterminate chlorosis, not always present, in the foliage.

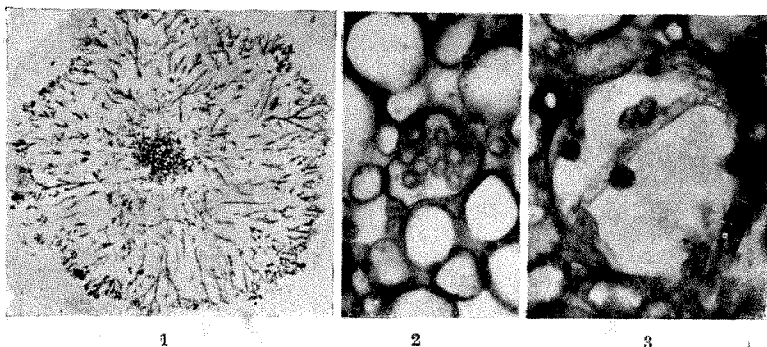
III. Non-virulent strain. Mosaic (mottling) only, of a pattern distinct from that shown by I, above.

IV. Non-virulent strain. Mosaic ('feather' type) quite distinct from the mosaics shown by I and II above.

The following Hemipterous insects, all common to *Th. Cacao*, were used in the experiments:—Aphid: *Toxoptera aurantii* Boyer; Psyllidæ: *Mesohomopterus tessmanni* Aulm.; Coccidæ: *Ferrisia virgata* (Ck.) *Pseudococcus citriabilis* Laing, *Pseudococcus* cf. *Risso*.

All phases of the work, except the identification of the coccids, for which I am indebted to specialists, were carried out by me personally. Prof. G. F. Ferris kindly determined *F. virgata* and *P. citri*, the identifications of other material of these species being confirmed by Dr. W. J. Hall; while Mr. F. Laing has been good enough to describe the new species of *Pseudococcus*, which appears to be indigenous on various forest trees and shrubs in the region under the name *citriabilis*.

Successful transmissions were obtained: (a) using the mealybugs, *F. virgata* and *Ps. citriabilis* with strain I of the virus; using *Ps. citriabilis* with strain II; and (c, d) using *Ps. citri* with strains III and IV, separately.



(1) TRANSVERSE SECTION OF THALLUS OF *Batrachospermum* sp. NEAR APICAL END OF CENTRAL CELL ($\times 22$). (2) AND (3) TRANSVERSE SECTIONS OF SAME CENTRAL CELL AS IN (1), THE FORMER BEING IN THE UPPER HALF OF THE CELL AND THE LATTER NEAR THE BASAL END ($\times 400$).

lumerous experiments with the aphid and the syllid, conducted under precisely similar conditions o those with the mealy-bugs, but using much larger umbers of individuals, consistently yielded negative sults. These results are given in the accompanying ble, in which the signs + and - indicate positive r negative results, respectively, in an adequate series, f experiments

Species of insect	Strain of virus			
	I	II	III	IV
<i>Ferrisiana virgata</i>	+	-	-	-
<i>Pseudococcus eximabilis</i>	+	+	-	-
<i>Pseudococcus citri</i>	-	-	+	+
<i>Toxoptera auranti</i>	-	-	-	-
<i>Vesohomotoma lessmanni</i>	-	-	-	-

The selective results suggest that more than one stinct virus may be concerned in the complex his is also to some extent confirmed by then effects i the plant (*vide supra*)

The earliest recognizable symptoms appeared in ie experimental plants five weeks after transfer of sects from infected plants. In the course of numer- is experiments, it was discovered that strain I ould be transmitted by one individual female of s *eximabilis*, also by this mealy-bug in its young rval ('crawler') stages. In one instance transmission eurred using females of this species, which were own to have lived on the infected source plant for ot longer than forty-eight hours. To ensure trans- ission, however, a minimum of ten females, prefer- ly with accompanying larvæ, is advised, and proof required that some of them have fed on both the fected source-plant and the uninfected experi- ental plant.

The work was carried out as part of a research ogramme financed by the Colonial Development d Welfare Fund. It is hoped to publish a full per elsewhere at an early date.

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Unification of the Physical Fields

SCHRODINGER has stated¹ "At the back of our iving for a unitary field theory, the great problem aits us of bringing it into line with quantum eory." With this, one may venture to differ, in o respects.

(1) Eddington answered Schrodinger's "great oblem" by bringing space-curvature into line with antum theory. He remarked² "In the theory of ativity energy and momentum are coefficients of rvature in space-time, in quantum theory they e characteristics of wave-functions in flat space is a big step towards unification of physics if we a find the precise connexion between these two ys of representing the same thing." He demon- ated that energy-momentum, usually expressed rms of curvature, can become expressed in rms of probability distribution, and thence in rms of wave-functions as in quantum theory.

(2) The problem is rather one of bringing quantum eory into line with space curvature.

The two ways of representing energy-momentum a be coalesced into a space-curvature representa- n. The steps are the inverse of Eddington's, obability distribution (wave function) is expressible

in terms of space-curvature. In this way the inverse of Schrodinger's problem can be answered, but in spite of this, he has to be content to realize¹ that he is ignoring "such features in the conventional de- scription of the physical fields as are concerned with their quantum character."

My own theory of indeterminate space-time³ is wholly inverse to Eddington's. Like Schrodinger, it uses the mathematics of relativity, and the axiom of the unsymmetrical affine connexion. Schrodinger is anxious to provide two mathematical entities in addition to the Einsteinian gravitational tensor, which are to be representative of the so-called meson field and the electromagnetic field respectively. Eddington has shown that the meson field is only an apparent but really non-existent range of the non-Coulombian interaction of two particles. My main purpose in using unsymmetrical affinity was to give the *uncertainty idea* a place in the primary axiom. For this purpose a number of components of affinity additional to those employed by Einstein was re- quired. These additional components were to carry latent in them all the potentialities of discontinuity, so necessary in connexion with quantum characteris- tics. By suitable provision at the commencement, energy-momentum, and *uncertainty*, appear as co- efficient of curvature, in quantum theory they are all three characteristics of wave-functions.

My treatment stipulates that the additional com- ponents of the unsymmetrical affinity have to be *indeterminate*. Indeterminacy has a plain connexion with uncertainty. This stipulation calls forth certain repercussions elsewhere. A most important one is the non-appearance of a meson field entity. If de- sired, one can use the extinction of the Schrodinger meson-field entity as a necessary condition dis- covering what the consequences are for the com- ponents of the affinity. Whichever way is chosen, the disposable components are indeterminate, and uncertainty unifies with the nature ascribed to space- time. This puts the meson field right out of the picture, in agreement with Eddington.

It is evident from Prof Schrodinger's work that by omitting my primary stipulation, there is obtainable a perfectly determinate space-time system, within which uncertainty, and therefore quantum theory, can find no place. (Neither does it appear that a true electromagnetic system is possible in that case, because that requires indetermi- nate potentials.)

Eddington distinguished between the abstract geometrical origin and the "physical origin" (arrived at by averaging the scatter of blurred physical land- marks), and from his studies arose a number of cor- rections of an elementary statistical character, on current inaccurate views. One such statistical in- accuracy accounts for the apparent range of the really non-existent meson field.

Indeterminate space-time retains Eddington's "physical origin" and co-ordinate system, and works with it, relegating uncertainty (scatter) to a place in the space-curvature. He called such a system "Sigma-metric." Schrodinger works with what Eddington called the abstract geometrical system. Our *physical* system cannot be compared with an academic, abstract geometry—in particular the com- mutative properties of second partial derivatives in the one has only an indirect relation to the other because the former is the subject of mathematical physics, whereas the latter is pure mathematics. It is these special commutative properties, to which I

refer, that have a direct bearing on quanta (that is, discontinuity). In my theory they give me the quantal part of the unification, in Schrodinger's, nothing, because they are in no way unusual.

A requirement in all electromagnetic problems is the proper statement of boundary conditions. So it is in respect of the energy of uncertainty. Once the boundary conditions are specified, the energy quanta become determinate. The boundary conditions for the quantal part of the problem and for the electromagnetic part are, not unnaturally, found to be the same in my analysis. This is where indeterminate theory links the indeterminism of electromagnetic potentials with the uncertainty principle of Heisenberg.

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¹ *Nature*, 153, 572 (1944)

² Eddington, Sir A. S., *Univ. Nacional d. S. Marcos Lima*, Ano XLVI, 447

³ *Nature*, 154, 94 (1944)

Isomorphic Relationship between Rubidium and Thallium in Igneous Minerals

V. M. GOLDSCHMIDT¹ has been able to demonstrate that the radius of an ion is a fundamental factor in regulating isomorphic behaviour, ions of like size being capable of replacing each other isomorphically within a crystal lattice. The application of this law of crystal chemistry to a study of the distribution of the elements in the earth's crust has yielded fruitful results, in particular, the behaviour of many of the rarer elements during the fractional crystallization of a magma is now reasonably well understood. For example, Goldschmidt² has pointed out that, since the radii of Rb⁺, Tl⁺ and Cs⁺ (1.49, 1.49 and 1.65 Å, respectively) are similar to that of K⁺ (1.33 Å), these elements are commonly found in potassium-rich minerals, particularly those of late pegmatitic phases.

As a result of the identity of the radii of Rb⁺ and Tl⁺, it was decided to investigate whether these two elements were quantitatively associated in igneous minerals, that is, capable of entering crystals of various types with the same facility. In all, seventy-two analyses of lepidolite (the richest mineral in both rubidium and thallium), zinnwaldite, amazonite, potash feldspars other than amazonite, phlogopite, muscovite and pollucite, have been carried out, and the analyses reveal a very close relationship between rubidium and thallium, the maximum variation of the ratio Rb₂O/Tl₂O being 35–450, that is, 10 × 1.3, with an average ratio of 135. The concentration range covered in these analyses is about a thousand, and throughout there is no apparent change in the ratio, the only apparent factor influencing the ratio being the relative initial paucity or richness of either element in a particular source.

Graphically, a plot of log per cent Rb₂O v. log per cent Tl₂O reveals that a straight line of unit slope accommodates these points most satisfactorily, that is, Rb⁺ and Tl⁺ enter crystal lattices and replace K⁺, and in the case of pollucite Cs⁺, with exactly the same facility. In contrast, analytical data on rubidium and caesium show that although these two elements

are invariably associated, the ratio Rb₂O/Cs₂O is very variable and tends to decrease with differentiation as a consequence of the larger radius of the caesium ion.

Direct evidence of the analogous isomorphic behaviour of Rb⁺ and Tl⁺ has been furnished by the analyses of more than one mineral from the same pegmatite, the ratio Rb₂O/Tl₂O remaining exactly constant.

This identity in the isomorphic behaviour of Rb⁺ and Tl⁺ during differentiation furnishes a striking and elegant example of the manner in which ionic size determines isomorphic behaviour and thus assists in regulating the distribution of the rare elements.

All the analyses embodied in the above investigation were carried out spectrographically.

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¹ Goldschmidt, V. M., *J. Chem. Soc.*, 655 (1937).

² Goldschmidt, V. M., *Trans. Farad. Soc.*, 25, 253 (1929).

Distribution of Wars in Time

A STATISTICAL regularity in the dates of wars has been brought to notice by the following numerical process. A list was prepared of wars in the world as a whole. Each calendar year was thereby characterized by the number, $x = 0, 1, 2, 3, 4$, of wars which began in it. Next, the number, y , of years which had each such character was counted. A similar procedure was applied to the beginning of peace. Here are some results:

War,	x	=	0	1	2	3	4	>4
Peace,	y	=	63	35	9	2	1	0
	y	=	62	34	13	1	0	0
	$110 e^{-\mu} \mu^x / x!$	=	62.0	35.5	10.2	1.9	0.3	0.0

where $\mu = 63/110$. The formula is the Poisson law of improbable events. Other phenomena, known to be described by the Poisson law, include the distribution in time of the alpha particles emitted from radioactive substances¹, or of deaths by kick from a horse².

This impersonal account of the beginnings of war and of peace contrasts with the personal details in the newspapers and history books. In somewhat the same manner the statistics of marriage contrast with a love-story in a biography. The Poisson law is statistical in the sense that it does not predict the date of any future peace or war.

The particular set of wars summarized in the above table are fatal quarrels, which caused from 10³ to 10⁴ deaths, and which ended from A.D. 1820 to 192 inclusive³. But the Poisson law, with other constants, also describes the beginnings of wars from A.D. 1500 to 1931, as set out in Prof. Quincy Wright's list⁴.

A more critical account of these regularities has been accepted for publication by the Royal Statistical Society.

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¹ Rutherford, Chadwick and Ellis, "Radiations from Radioactive Substances" (Camb. Univ. Press, 1930), 172.

² Bortkewitsch, quoted by Pearson, K., "Tables for Statisticians" (Cambridge University Press, 1914), lxxvii.

³ *Nature*, 148, 598 (1941).

⁴ Wright, Q., "A Study of War" (University of Chicago Press, 1941) appendix xx.

CIVILIAN CONTRIBUTION TO EDUCATION IN H.M. FORCES

THE report of the Central Advisory Council for Adult Education in H.M. Forces for the six months ending September 1944 presents further evidence of the remarkable growth of education in the Services and of the inestimable contribution made by civilians. During the period under review (19,023 single lectures, 2,955 short courses (average number of meetings 5), 2,358 classes (average number of meetings 9), and 348 intensive schools, leader's courses and conferences, are known to have been arranged through the agency of regional committees besides these activities, other classes were arranged by local education authorities direct with the Services, while many other informal meetings are difficult to represent statistically. By far the greatest quantity of work was done for the Army, especially the Anti-Aircraft Command, but a considerable amount was done for the Navy, the Royal Air Force, and the United States Forces. Since much of the educational work is co-educational, it is difficult to show how much advantage was taken by the Women's Services of regional committee facilities, but the amount of all-women activities was approximately one-sixth of the whole.

Analysis of the subjects taken shows that, as usual, current affairs accounted for the greatest demand in lectures and short courses. Of the classes, handicrafts and languages were most popular. An illuminating comment on the work as a whole is that the number of handicraft classes continued to show substantial increases, despite the all-round tightening in the supply of tools and materials. There was an increased demand for single lectures on science topics, and a considerable rise in the number of classes in 'non-vocational' science. This interest in science was undoubtedly stimulated by those regional committees which made deliberate attempts to provide facilities and to make them widely known. The response was particularly encouraging where it was possible to cater for voluntary audiences. It is unlikely, however, that any great demand for science will be forthcoming until there are far more science lecturers and teachers who will pay at least as much attention to the presentation of their subjects as to their content.

In music, the demand continued to be for general talks and discussions, and piano and gramophone lecture-recitals, although many analytical lectures and classes in the history and appreciation of music were also held. Wherever suitable lecturers were available, the demands for drama were more than enough to keep them fully occupied. A number of lay-reading circles and speech-training classes were formed, while drama festivals were organized and assisted. Much was also accomplished at music and drama week-end schools, which are extremely popular as a voluntary activity with members of both men's and women's Services. On the arts side, the main task was in the raising and maintaining of standards, the development of creative work, and the widening of the range of crafts practised on many lines, rather than the expansion of pioneer work among the various informal activities undertaken, a widening advisory service, which was arranged by the regional committee, invites comment. This ser-

vice supplied notes on food production, as well as personal advice. 95,000 plants raised in the university botanic gardens were distributed to units taking advantage of the advisory scheme last season. These included vegetables, shrubs, herbaceous plants, alpinists and annuals, in addition to gift boxes of American vegetable seeds. Figures of produce yields are not available, but the quality of cultivation was said to be high.

Of the 348 intensive schools provided by the regional committees, 101 were residential and more would have been if accommodation had been available. Towards the end of the summer, several committees planned to provide residential hostels to be used solely for their Service work, and, during the autumn, one hostel in England and another in Scotland were opened. It would be impossible here to describe adequately the different courses held, but the following may be regarded as illustrative examples. One regional committee arranged a series of seven voluntary week-end courses in music, drama, the film, art, science, literature, and the art of living. About sixty students attended each week-end, and there were waiting lists of up to a hundred for each course. To assist in the training of teachers for the Release Period Education Scheme (*Nature*, 154, 525, 1944), five regional committees serving an Army Command arranged a series of courses, each of a fortnight in duration, in science, history, geography, literature and economics.

Perhaps the most astonishing feature of the report as a whole is that it was possible to carry on so many educational activities during one of the major climacterics of the War. For many of the committees, the period was a difficult one owing to the uncertainty of the demand from week to week. The slight decline in the number of single lectures and short courses was more than counterbalanced by the increase in the total number of classes. In many ways this was an advantage, and one committee reported that "Education in the Services has probably approached more closely to civilian peacetime adult education than before. Previously we had to maintain an uneasy balance between keeping the units amused and encouraging them to think for themselves, and since the lecturers who can do both are rare, the sheer volume of demand in the past obliged us to use (more frequently than we liked) the 'popular' lecturer for pioneer work. With a smaller demand, we have been able to use lecturers of a considerably higher standard." The Central Advisory Council, the regional committees, and all the civilians who have helped in this richly consequential work deserve the warmest commendations of a democratic country.

Service men and women at home have shown their gratitude for the work done for them by these civilians, and, to a lesser extent, those serving abroad are now being given an opportunity to share in the facilities. Recently, a scheme was started whereby prominent civilians make tours abroad to lecture to H.M. Forces. Some of these visits have been concluded with memorable results. It is pleasant to note that, during the next few months, some well-known men of science are to take part in this overseas lecturers scheme. With lessening demands on them for purposes of war, perhaps more of them will be freed to take part in this valuable work.

The report was issued by the Central Advisory Council for Education in H.M. Forces (secretary, Dr Basil A. Yeaxley) at Rewley House, Oxford.

THE DURHAM COALFIELD

THE fuel technologist, the mining engineer and the geologist will find material of interest in the Regional Survey Report on the Durham Coalfield.* The pressing needs of war have revealed serious defects in the organization and technical efficiency of British coal-mining, and the Minister of Fuel and Power has wisely decreed that the basis of any attempt to create an efficient and prosperous mining industry is a national stock-taking of the already depleted coal resources of Great Britain.

At an early stage in the report it is made clear that this coalfield has made, and will continue to make, a vital contribution to the national economy. Durham coals vary much in character, but this area is justly renowned for its coking and gas coals, described as "probably the best in Europe". In West Durham certain of the seams yield coal which produces an excellent metallurgical coke, hard in texture and low in sulphur and phosphorus—a coke in great demand for foundry and general metallurgical work. Emphasis is very properly laid on the fact that the seams yielding the best coking coals have but a limited life, and it is estimated that, at present rates of production and consumption, the total coking coal reserves will be extracted within seventy years. The conservation of these resources of coking coal is clearly a matter of first importance, and the report makes a significant reference to the considerable export trade prevailing in this class of coal in normal times. Almost the whole of the coalfield produces gas coals of good quality. Much of the coal required by the gas works of London and the south coast comes from Durham, and prior to the War, Durham coal was shipped to many of the European gas works.

There has been much speculation as to the probable life of the British coal seams, but it is certain that the regional surveys will provide data for reasonably accurate estimates. Since previous attempts to arrive at the coal reserves of Great Britain much information has been compiled by the Geological and Fuel Research Surveys, while the financial transaction involved in the nationalization of mineral royalties necessitated the preparation of proposals for working during the next thirty years, with an estimate of the reserves remaining in 1972. With certain reservations, the estimated reserves of the Durham Coalfield are given as 3,000 million tons. It appears that this is a conservative estimate, many thin and low-quality seams are not included in the figure, and it is also probable that there are further substantial reserves of under-sea coal. In 1938, the output was approximately thirty-three million tons, so that at this rate of production much of the Durham Coalfield will be exhausted in the next hundred years. Nevertheless, coal will continue to be produced from this area for a much longer period, seams not now regarded as a commercial proposition may well prove workable in the years ahead, "providing, as it were, a second harvest".

The conditions prevailing in the under-sea areas are of great importance to the coalfield. It is disappointing to read that there are deteriorations in certain seams as they pass seawards. The Durham Coalfield is apparently affected in the same way as the East Midland Coalfield, which suffers a marked deterioration in the seams underlying its eastward

extension. Exploration has been carried to a small distance beyond the three-mile limit, but it is expected that one or two of the better seams will be workable for a distance of six miles or more out to sea.

An astonishing feature of the report is the statement that some 738 million tons of coal have been sterilized for one reason or another. The bulk of the coal has been left in order to avoid damage to buildings by mining subsidence, and the report states that if arrangements could be made for supporting the surface by stowage, some 468 million tons of the sterilized coal might well prove economically workable. Since sterilized coal has not been included in the estimate of total reserves, and represents about 25 per cent of the latter figure, it is clear that the introduction of modern methods of stowage would result in a considerable addition to the resources of the coalfield. To obviate further undue sterilization of Durham coal, care is needed in the selection of sites for future houses and buildings.

The industrial life of this area is based on its high quality coal seams, and any consideration of future prospects must take into account the possibilities of using coal as a basic raw material. Included in the report is a short account of the findings of the Coal Processing Industries Panel of the North-East Chemical and Allied Industries Development Committee. It is made clear that the establishment of new coal-processing industries will involve a very large capital expenditure, and that the success of any project of this nature will be dependent on adequate co-ordination. "The Gas-Grid Scheme, the extraction of olefines, methane and other gases, the production from these of chemicals and plastics, the conversion of coke to petrol, Diesel oil and other hydrocarbons are all inter-related, and part of one comprehensive coal processing project."

The remainder of the report deals with the possibilities of de-watering a large tract of flooded coal south-west Durham, the question of increasing productivity by further mechanization of the mines, and the housing requirements of the mining community. As a guide to the present position and future of the coalfield, the report is a document of major importance, of interest to all who believe that the future of Britain is dependent on the proper use of our remaining coal resources.

H. HARTLEY

REFORM OF THE PATENT LAW IN BRITAIN

DURING the past few years, there have been many allegations that monopoly rights created by patents for inventions are being used contrary to the public interest by large industrial corporations. One suggestion which has been mooted in Great Britain for rectifying this alleged abuse is that each patent shall be granted subject to the condition that any person may obtain a licence to work the invention on terms to be agreed with the patentee or, in case of disagreement, to be settled by the Comptroller-General of Patents. This suggestion, in its original form, has not met with general acceptance, and a modification of it is put forward by Prof. Polanyi in a pamphlet reprinted from the *Review of Economic Studies*, entitled "Patent Reform: a Plan for Encouraging the Application of Inventions".

Prof. Polanyi expresses the opinion that to grant all patents subject to compulsory licensing on terms

* Ministry of Fuel and Power. Durham Coalfield Regional Survey Report (Northern "B" Region). Pp. 48. (London: H.M. Stationery Office, 1945) 1s net.

be settled by the Comptroller would produce actually the same results as if patents had been abolished altogether, he suggests an alternative system under which licensing is supplemented by Government rewards to patentees on a level ample enough to give general satisfaction to inventors and their financial promoters. In operating the system, patents would be granted by the Patent Office in accordance with the present law and, shortly after a patent had been granted, the Comptroller would lay down obligations to be fulfilled by licensees. These obligations would have only one purpose, namely, to ensure the assessment of the economic value created by the invention. Licensees would have to make returns to patentees on certain technical points designated to them and, on these returns, patentees would base their own assessment of the economic value created by the invention. The Government would undertake to pay annually to patentees a fixed fractional part—perhaps one-tenth or one-third—of the approved total of assessed values created by the invention during the previous year as an integral part of the system that public rewards could be so adjusted as to make them sufficiently attractive to inventors and backers of inventions in general. In many cases, the process of assessing the economic value of the invention for purposes of rewarding the patentees might be carried out directly.

Government inquiry, to the exclusion of any reports by licensees to patentees. It is claimed by Prof. Polanyi that under the existing system the presence of the attributes of novelty, utility and subject-matter in each invention leads to serious abuses of legalism and to consequent inequitable remuneration of inventors, and that his system would provide an equitable reward for each of the investigators taking part in the production of a patentable invention. He foresees, however, two dangers, though he is of opinion that each can be avoided. In order to obviate the danger of corruption and arbitrary oppression, which is never far removed from the grant of Government subsidies, the whole procedure of their assessment should be made fairly rigid, by requiring the returns on which they are based to include only data endorsable by accountants' certificates. Further, in his opinion, the fact that considerable sums of public money would be required under his system, in order to pay rewards to patentees, not be held against it because the burden would be more than offset by the benefits accruing to the public.

It is possible that in respect of each of these dangers Prof. Polanyi is too optimistic. The reluctance of the British Government to provide public money to produce benefits that cannot be readily shown to be due to the money so used is well known, and it is not at all certain that a Government would provide an amount of public money that would be accepted as adequate by patentees and their financial backers, and at the same time be recognized by the public as reliable.

Further, experience has shown that the danger of corruption and arbitrary oppression is not easily avoided. One outstanding example of direct government rewards to inventors is the system at present in operation in the U.S.S.R. There, a special form of patent protection was established in 1931 which entitled the inventor to receive certain fixed compensation and various living or social privileges, and which contained elaborate provisions for the testing and exploitation of inventions. On March 5, 1941,

the Council of People's Commissars of the U.S.S.R. promulgated a decree introducing a new "Inventions Statute" and repealing the former one dated April 9, 1931. The following extract from *Pravda* of April 15, 1941, stated its objects:

"The main object of the revision is to establish a definite procedure for examining and consummating inventions and technical improvements and to give a number of privileges to inventors to protect them from bureaucrats and procrastinators."

"The Statute establishes definite periods within which offers of inventions and technical improvements must be accepted or rejected, or definite tests inaugurated. The reason for these rigid regulations is that we have not yet got rid of our bureaucrats, who beat off inventors like importunate flies. There are inventors who for five years have been sitting on the doorsteps of commissariats, trusts, newspaper offices and complaints offices in a vain endeavour to get an answer as to the fate of their proposals."

Even if Prof. Polanyi's hope of avoiding these dangers is realized, it is not clear how his system will overcome the fundamental difficulty raised by compulsory licensing of all patents. So far as Great Britain is concerned, after an inventor has obtained the grant of a patent, either he or his financial backers must provide the capital necessary to work the invention in this country on a commercial scale if it is desired to retain the monopoly. If the monopoly is lost by compulsory licensing, the difficulty of providing this capital will be increased, for not many inventors or their financial backers will be prepared to erect plant for the commercial exploitation of an invention with the risk that it may be a failure, if their competitors are at liberty to obtain a licence should it be a success.

CAROTENE AND SUGAR CONTENT OF CARROTS

THE nutritional value of carrot roots is due largely to their contents of carotene and sugar, and both these constituents are most abundant in the phloem. It is of interest to note, therefore¹, that although the phloem constitutes more than 60 per cent of the root the proportion is greatest in young roots, although carotene content increases with maturity but is least in 'large strain' carrots². Carotene content is influenced by manuring, but carotene losses during storage are negligible until the stored roots sprout in the spring. Although sugar content is often a good index of 'quality', the correlation between desirable taste and refractive index of the juice is often upset by the presence of an unidentified bitter constituent³.

Maintenance of high quality (that is, high sugar stocks) may be difficult, as these roots when replanted for seed production often rot and so fail to produce a satisfactory crop of seed⁴. Seed production, too, may be complicated by the temperature requirements of the carrot⁵, H. S. Sakr and H. C. Thompson reporting that the initiation of flower primordia is inhibited at temperatures in excess of 70° F. although doubtless the critical inhibiting temperature is influenced by the previous history of the carrot.

Not less important than the taste and sugar content is the shape of the roots, and traditionally carrots are grown on land "manured for a previous crop", fresh animal manure being thought to induce

branching or forking of the roots G J Raleigh⁶ reports, however, that with carrots in sand culture supplied with a complete nutrient solution, the addition of cow manure free from urine did not increase the amount of root branching, but cow or horse urine did cause forking. Attempting to discover what substances were responsible for this effect, Raleigh found that urea, ammonium hydroxide and ammonium carbonate all induced root branching, but a variety of growth-substances tried were without effect

¹ Werner, H O, *Proc Amer Soc Hort Sci*, 38, 267 (1941)

² Pepkowitz, L P, Larson, R E, Gardner, J, and Owens, G, *Proc Amer Soc Hort Sci*, 44, 468 (1944)

³ Brown, H D, Miller, M K, Alban, K, Schulkers, R, and Murmane, C, *Proc Amer Soc Hort Sci*, 44, 465 (1944)

⁴ Ellis, M K, *Proc Amer Soc Hort Sci*, 40, 536 (1942)

⁵ Sakr, H S, and Thompson, H C, *Proc Amer Soc Hort Sci*, 41, 843 (1942)

⁶ Raleigh, G J, *Proc Amer Soc Hort Sci*, 41, 347 (1942)

FORTHCOMING EVENTS

Saturday, May 19—Monday, May 21

ASSOCIATION OF SCIENTIFIC WORKERS (at the Beaver Hall, Garlick Hill, London, E C 4), Annual Council Meeting

Saturday, May 19

At 2-6 p.m.—Address by Prof P M S Blackett, F R S (president), and discussion on future policy for science

Sunday, May 20

10 a.m.—6 p.m.—Education policy Debate on a proposal to initiate a political fund Report on industrial work, negotiations with employers, etc Motions on the Trades Disputes Act and the National Health Service

Monday, May 21

10 a.m.—1 p.m. Relations with scientific organizations overseas

Tuesday, May 22

INSTITUTION OF ELECTRICAL ENGINEERS (RADIO SECTION) (at Savoy Place, Victoria Embankment, London, W C 2), at 5.30 p.m.—Discussion on "Non-Ferrous Contact Springs" (to be opened by Dr H G Taylor and Dr L B Hunt)

QUAKETT MICROSCOPICAL CLUB (at the Royal Society, Burlington House, Piccadilly, London, W 1), at 7.30 p.m.—Mr E R Newmarch "Fluid Mounting, with special reference to Narcotizing and Fixing Polyzoa"

Wednesday, May 23

ROYAL SOCIETY OF ARTS (at John Adam Street, Adelphi, London, W C 2), at 1.45 p.m.—Mr Paul Adorjan "Wire Broadcasting" (Thomas Howard Lecture)

PHYSICAL SOCIETY (at the Royal Institution, Albemarle Street, London, W 1), at 4 p.m. Presentation of Duddell Medal to Dr F W Aston, F R S

Prof E N da C Andrade "The History and Future of the Physical Society" (Presidential Address) Annual General Meeting

Thursday, May 24

INSTITUTION OF ELECTRICAL ENGINEERS (at the Institution, Savoy Place, Victoria Embankment, London, W C 2), at 5.30 p.m.—Mr J C Bead "High-Voltage Steel-Tank Mercury-Arc Rectifier Equipments for Radio Transmitters", Mr P A T Bovan "The Application of High-Voltage Steel-Tank Mercury-Arc Rectifiers to Broadcast Transmitters"

ASSOCIATION FOR SCIENTIFIC PHOTOGRAPHY (at Caxton Hall, London, S W 1), at 7.0 p.m.—Annual General Meeting At 7.30 p.m. Mr S H Thorpe "Photography applied to Research in the Steel Industry"

Friday, May 25

ROYAL COLLEGE OF SURGEONS (at Lincoln's Inn Fields, London, W C 2), at 4 p.m.—Prof Arnold Sorby "Blindness in Great Britain: the Structure of the Blind Population and the Causes of Blindness"

ROYAL INSTITUTION (at 21 Albemarle Street, London, W 1), at 5 p.m.—Sir Geoffrey Taylor, F R S "The Internal Structure of Turbulent Fluid Flow"

APPOINTMENTS VACANT

APPLICATIONS are invited for the following appointments on or before the dates mentioned

SENIOR TECHNICAL OFFICER in the War Department Power Plants (Mechanical) Branch, Military College of Science, School of Tank Technology, Chertsey, Surrey—Ministry of Labour and National Service, Central (T and S) Register, Room 5/17, Sardinia Street, London, W C 2 (quoting Reference No C 2558 A) (May 22)

LECTURER IN MECHANICAL and/or ELECTRICAL ENGINEERING SUBJECTS at the Technical College, Cardiff—Director of Education, (C Hall, Cardiff) (May 22)

LECTURER IN THE CERAMICS DEPARTMENT, North Staffordshire Technical College, Stoke-on-Trent—The Principal (May 26)

LECTURER IN ELECTRICAL ENGINEERING at Aston Technical College, Birmingham—Chief Education Officer, Birmingham Education Committee (May 28)

SENIOR LECTURER IN AERODYNAMICS at the Royal Aircraft Establishment Technical School, Farnborough—Ministry of Labour and National Service, Central (T and S) Register, Room 5/17, Sardinia Street, London, W C 2 (quoting Ref No C 2571 A) (May 28)

RESEARCH POMOLOGIST at the Department of Agriculture Horticulture, University of Bristol, at Long Ashton Research Station—The Secretary and Registrar, University, Bristol, 8 (May 31)

PROFESSOR OF AGRICULTURE AND DIRECTOR OF THE COLLEGE F at the University College of North Wales, Bangor—Acting Registrar (May 31)

PROFESSOR OF MATHEMATICS at the University College of North Wales, Bangor—The Acting Registrar (May 31)

LECTURER IN ANTHROPOLOGY with special reference to West African TUTOR IN COLONIAL WELFARE PROBLEMS, LECTURER IN ECONOMIC and LECTURER IN INTERNATIONAL RELATIONS at the London School of Economics and Political Science—The Acting Secretary, London School of Economics, The Hostel, Peterhouse, Cambridge (May 31)

AN ASSISTANT CHIEF ENGINEER (MECHANICAL) (Ref No C 2589 J) and an ASSISTANT CHIEF ENGINEER (CONSTRUCTION) (Ref No C 2590 XA) at the Tata Iron and Steel Co., Ltd, Jamshedpur, Ind Ministry of Labour and National Service, Central (T and S) Register Room 5/17, Sardinia Street, London, W C 2 (quoting appropriate reference number) (May 31)

LECTURER IN GEOGRAPHY at King's College, University of London The Secretary, King's College, Strand, London, W C 2 (June 1)

LECTURER IN ELECTRICAL ENGINEERING, with knowledge of MECHANICAL ENGINEERING, at the Ipswich School of Technology—The Education Officer, Education Department, 17 Tower Street, Ipswich (June 1)

DIRECTOR OF THE SCHOOL OF LIBRARIANSHIP, University of London—Academic Registrar, University of London, Richmond College, Richmond, Surrey (June 1)

PROFESSOR OF GEOGRAPHY at the London School of Economics Political Science—The Academic Registrar, University of London Richmond College, Richmond, Surrey (June 4)

LECTURER IN PHYSICS at Loughborough College, Leics—Registrar (June 7)

DEMONSTRATOR and also TECHNICIAN IN THE CHEMISTRY DEPARTMENT, Guy's Hospital Medical School, University of London—G S Gibson, F R S, Chemistry Department, Guy's Hospital Medical School, London Bridge, S E 1 (June 16)

TWO UNIVERSITY LECTURERS IN MATHEMATICS at Cambridge The Secretary of the Appointments Committee (Dr R Stoneley), 1 broke College, Cambridge (June 30)

DEMONSTRATOR IN METALLURGY in the University of Cambridge The Secretary of the Appointments Committee of the Faculty of Physics and Chemistry (Dr F B Kipping), University Chemistry Laboratory, Pembroke Street, Cambridge (July 2)

READER IN ANTHROPOLOGY at the London School of Economics and Political Science—The Academic Registrar, University of London Richmond College, Richmond, Surrey (July 9)

PROFESSOR OF BACTERIOLOGY at University College Hospital Medical School—The Academic Registrar, University of London Richmond College, Richmond, Surrey (Sept 24)

A LECTURER IN GEOGRAPHY and a LECTURER IN BIOLOGY at Hill Training College, London—Principal, at Sandy Mount, Croft Moor, Huddersfield

LECTURER IN BOTANY at Birkbeck College, University of London—Clerk, Birkbeck College, London, E C 4

LECTURER IN MATHEMATICS at Woolwich Polytechnic, London S E 18—The Secretary and Clerk to the Governors

RESEARCH ASSISTANT (female) with Biological or Zoological qualifications at the Christie Hospital and Holt Radium Institute, Withington Manchester 20—The General Superintendent

TEACHERS OF MATHEMATICS, CHEMISTRY, METALLURGY, MECHANICAL ENGINEERING at the County Secondary School and Cumbe Technical College, Worthington—The Principal

SENIOR ASSISTANT IN THE DEPARTMENT OF METALLURGY, LECTURERS IN THE DEPARTMENT OF ELECTRICAL ENGINEERING, LECTURER IN BUILDING SCIENCE, LECTURER IN PHARMACOLOGY SUBJECTS (temporary) at the Birmingham Central Technical College, Suffolk Street, Birmingham—The Principal

REPORTS and other PUBLICATIONS

(not included in the monthly Books Supplement)

Great Britain and Ireland

Reports of the Council and Auditors of the Zoological Society of London for the year 1944 Pp 101. (London Zoological Society 1945)

Institution of Gas Engineers Copyright Publication No. 270 Estimation of Small Quantities of Nitric Oxide. Pp 4 (Lor Institution of Gas Engineers, 1944)

The Physical and the Human Geography of the British Isles, a map in eight Colours (In English and Polish) By Dr Zofia H Pacewicz Pp 38 (Glasgow Książnica Polska, 1944)

Geological Survey of Great Britain Wartime Pamphlet No Economic Geology of Canonbie Coalfields (Dumfriesshire and Galloway). By B Hilton Barrett and Dr J A Richey, assisted by J Graham, with Appendices by Dr A E Trueman and Dr R Cro Pp 54 (London Geological Survey and Museum, 1945) 2s 6d

NATURE

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TELEVISION AFTER THE WAR

ONE of the most remarkable achievements in the application of science to the everyday life of the community was the development of television before the War. The first public service of high-definition television, in Great Britain or any other country, was inaugurated at the British Broadcasting Corporation's station at Alexandra Palace in November 1936. Prior to the closing down of the station for military reasons in September 1939, the television service had reached a high standard, the programme technique had made great progress, and the result was a service of considerable entertainment value. Some twenty thousand television receivers were in use by the general public, and although the service was confined to the London area, it is probable that several hundred thousand persons were more or less regular 'viewers' either in their own homes or elsewhere. These and many others have probably been wondering for some time past exactly what are the prospects of television after the War, and to what extent the lead which Britain established in this field nearly ten years ago will be maintained in the future. There has naturally been some cause for anxiety in this matter, since the United States had the advantage of more than two years of continued development on an almost peace-time basis after the outbreak of war in Europe, and even to-day there are in the United States a number of television transmitting stations in operation on an experimental or other basis.

Although for some years past the entire technical resources of Britain have been mobilized for the provision and operation of radio equipment required for the conduct of the War, a few members of the industry, Government establishments and the B.B.C. have been able to give some thought to matters concerning the future organization of a television service. For example, a paper entitled "A Survey of the Problem of Post-war Television" was read by Mr B. J. Edwards before the Radio Section of the Institution of Electrical Engineers last year, and the paper, with the extensive discussion which followed it, have recently been published in the *Journal of the Institution* (91, Part III, 163, December 1944). Technical discussions before the same Institution on matters affecting the improvement of television were also held in the previous year (*J. Inst. Elec. Eng.*, 90, III, 147 and 91, III, 11). More recently, Mr H. L. Kirke, of the B.B.C., has given a discourse on the subject before the Royal Institution, an abstract of this will be found on p. 621 of this issue of *Nature*.

In the meantime, the Television Committee, appointed in 1943 under the chairmanship of Lord Hankey, has completed its duties, and its report, issued a short time ago, provides a very careful and authoritative review of the whole subject.*

The Television Committee was charged with the duties of preparing plans for the reinstatement of the

* Report of the Television Committee Pp 26 (London H.M. Stationery Office, 1945) 6d net

television service of Great Britain and its extension to the larger centres of population, and of considering the provision to be made for research and development and the guidance to be given to manufacturers, with a view especially to the promotion of the export trade. The report opens with a reference to the first Television Committee under the chairmanship of the late Lord Selsdon, and to the installation of the Alexandra Palace station after the report of this committee (Cmd 4793) was published in 1935.

It is now generally recognized that past research work on television contributed very materially to the successful and rapid development of radiolocation, but the Committee finds that war research has produced little information and no discovery of a fundamental character bearing directly on television. War demands and activities have, however, greatly extended the technique of the radio engineer, and increased the number of skilled men and women who will eventually be available in all grades for the work of development, design and maintenance of television.

With these considerations in mind, the Committee's first and foremost recommendation, which is supported by the majority of the witnesses from whom it received information and advice, is that the pre-war system of television on the basis of 405-line definition should be restarted in London (Alexandra Palace) as soon as possible after the cessation of hostilities in Europe. An appendix to the report gives a description of this London Station and of the Maconi-E M I system used there, it is believed that the service could be restored to operation within nine to twelve months of the release of the requisite staff. Next, with the view of securing a full development of the television industry and making a larger section of the population television-minded, it is recommended that an extension of the existing system to the provinces should be planned, essentially for the dissemination of the same programmes over a larger area of the country. Thirdly, the Committee recommends that vigorous research work on a radically improved system of television should begin immediately staff can be made available, and that the objective in this case should be the cinema standard of definition of the order of 1,000 lines with, if practicable, the introduction of colour and stereoscopic effects. The scope of the extension of the existing system to provincial centres should be kept under review, so that any improvements, resulting from the research work suggested, may be introduced as early as possible to the public service.

Having stated in the above general manner the policy recommended by the Committee for the provision and development of a post-war service, the report then proceeds to a discussion of some details of the plans required to put these proposals into effect. It will be necessary to obtain agreement with the various interests concerned on the allocation of appropriate frequencies for television transmission both in the immediate and more distant future. Associated with this problem is that of electrical interference, which to a considerable extent hampered or restricted the successful reception of pre-war television programmes. As the potential sources of

such interference are likely to be far more numerous after the War, it is considered to be vital to the success of television that the Postmaster-General should be granted the necessary powers to enforce suppression of such interference.

On the question of research, two entirely different courses have been considered, neither of which is considered to be likely to lead to the most efficient and economical progress. It has been suggested that there should be complete unification of research effort of all interested firms in the formation of a research association, and alternatively, that the development of an improved system should be left to free competition between large firms, apart from research on certain fundamental problems on radio wave propagation, which would probably be undertaken in any event by Government institutions. In place of these suggestions, the Committee recommends that, while individual effort should receive all possible encouragement, television research should be co-ordinated, with the collaboration of all the interests concerned. It is understood that the Government research organizations of the Department of Scientific and Industrial Research would be prepared to assist the industry in any way possible in the development of television. The British Broadcasting Corporation will doubtless be able to assist considerably in co-ordinating effort in the development of an improved system, while the Post Office will assume responsibility for the outstanding problems of relaying programmes by cable and radio links. Since the ultimate aim of all interested parties is the establishment of the best television service, and as it is probable that only one transmitting system—as distinct from receiving apparatus—will be chosen for the new British service, the problem of patents becomes one of special difficulty. This problem appears to be essentially one for the industry, and it is recommended that the manufacturing firms should be encouraged to pool their television patents with the view of ensuring that they are made available for use as the national interest may demand.

The Committee gave special consideration to the item in its terms of reference concerned with the development of the export trade, an aspect of television to which the industry appears to be thoroughly alive. General agreement was found in the fact that the first step in this direction is to popularize television at home, since a flourishing home market in suitable receivers is an essential pre-requisite of an export trade. While the industry itself must be responsible for the development of such trade, it should keep a close watch on possibilities and prospects, and arrangements should be made for the Government to be advised of developments in the television system so that these may be brought to the notice of Dominion and foreign Governments. Partly in this connexion, the Committee has given much thought to the question of bringing the British television standards into line with the American pre-war standards based on 525 lines per picture. It is implicit in the recommendations already described to re-establish the London station on its previous basis of 405 lines that such a change is considered to

not worth while at the present time. It is urged, however, that the ideal of international standardization should be kept constantly in mind, not only for line and picture details, but also for the bands of frequencies of radio carrier waves allocated to television.

An important section of the Committee's advice is concerned with the organization and administration of the television service and with the financial arrangements involved therein. Before the War, the Minister responsible for television on behalf of the Government was the Postmaster-General. The question of future arrangements is part of the wider subject of the relations between the Government and

British Broadcasting Corporation, which is a matter outside the terms of reference of the present committee, it is suggested, however, that the Minister responsible to Parliament for sound broadcasting should also be responsible for television. In this way, it is considered desirable that the B B C should operate the television service, owing to its connexion with sound broadcasting. After making estimates of the cost of re-opening the television service and its extension to the provinces, it is recommended that domestic television viewers should be required to have a special licence at a fee of £1 a year. It is also suggested that a cinema television licence might be introduced in the future, and this might become an important source of revenue. The interests concerned have, however, estimated that except possibly in the case of isolated areas, they will not desire to embark on the use of television in cinemas until a new and improved system has been adopted. The report also refers to the possibility that an appreciable amount of revenue might be derived from the inauguration of sponsored television programmes with appropriate advertising charges paid for by commercial interests. It is recognized that this question raises wider issues than merely financial ones, and it is felt to be premature to come to a conclusion thereon at the present time. Much of the success of the development of television before the War was due to the activities of the Television Advisory Committee, which was set up in accordance with the recommendations of Lord Don's Committee. The present Committee endorses this procedure by recommending that the Minister responsible for broadcasting should appoint a corresponding committee to fulfil a similar purpose, any rate until the service is more or less stabilized. It is suggested that this advisory committee should include representatives of the Treasury, the General Post Office, the Department of Scientific and Industrial Research and the British Broadcasting Corporation, its function would be generally to advise the responsible Minister on questions of major policy on any problems arising from the development of television both at home and abroad.

Under the guidance of such a body, which would fully consider all phases of the report recently published and, where necessary, ensure that the recommendations are implemented in the most judicious and efficient manner, it can confidently be anticipated that television will develop on sound

lines in Britain and maintain the position and prestige which had been so well established some six years ago. There is no doubt that television has come to stay, and has already reached a stage that gives satisfactory results in the home. British science, engineering and industry, working in co-operation with the B B C on the lines suggested in the present report, can be trusted to produce an improved system which will contribute worthily to the progress of an art the significance of which for international understanding can even now scarcely be exaggerated.

THE MOTOR AREA OF THE BRAIN

The Precentral Motor Cortex

By Charles D. Aring, Percival Bailey, Gerhardt von Bonin, Paul C. Bucy, Charles Davison, Theodore C. Erickson, John F. Fulton, Marion Hines, Margaret A. Kennard, Paul M. Levin, Warren S. McCulloch, James L. O'Leary, Wilbur K. Smith, Sarah S. Tower, A. Earl Walker. Edited by Paul C. Bucy. (Illinois Monographs in the Medical Sciences, Vol. 4, Nos. 1-4.) Pp. xiv + 605. (Urbana, Ill.: University of Illinois Press, 1944.) 4.50 dollars.

THE opening pages of this book are a sharp reminder of the misfortunes of Europe. It is dedicated to Otfried Foerster, the great neuro-surgeon of Breslau, and the foreword by John Fulton recalls the work of Dusser de Barenne at Utrecht. Dusser de Barenne left Utrecht for Yale in 1930, and the main development of his new methods took place there. But to many members of the Physiological Society his name will recall their visit to Holland in 1925, where they saw Einthoven at Leyden with his string galvanometers, Dusser de Barenne, Zwaardemaker and de Kleijn at Utrecht, and Magnus with his team of neurologists in the old plague hospital of the town. They will remember the cheerful and almost overwhelming hospitality of their Dutch colleagues, the fine buildings and the prosperous countryside.

The precentral motor cortex certainly deserves a volume to itself, for most of our knowledge of the brain has been derived from its study. When Fritsch and Hitzig found in 1870 that electrical stimulation of this part of the cerebrum would produce localized movement of the limbs, an entirely new chapter of cerebral physiology was opened. It became possible to trace the pathways of conduction, to map the excitable areas in different animals, and to analyse the movements caused by stimulation. No other part of the brain surface could yield such a rich harvest, for in no other part would electrical stimulation give such obvious results. The maps have become more and more detailed, with the inclusion of the anthropoid apes and of man in the series, and the method now seems to be reaching the limit of its usefulness. Indirectly, however, there is no field of research on cerebral localization which is not derived from these early studies of the motor area.

Otfried Foerster was the first to make extensive use of electrical stimulation of the human brain in the course of neuro-surgical operations. Dusser de Barenne introduced the use of strychnine instead of the electric current to stimulate the cerebral nerve cells. He employed it originally in investigations of the sensory area, applying it locally to the cortex and

judging the results by the disturbance of sensation which it seemed to induce. The results were striking, but it was not until he began to record the electrical activity of the cortex that the full possibilities were evident. Strychnine is a convulsant drug which produces an explosive discharge of the nerve cells, and this gives rise to characteristic electrical activity wherever the axons of these cells are to be found in sufficient numbers. Thus the axons leading from any point on the cortex can be followed to their destination by applying strychnine to the point and finding what other regions give the large 'strychnine spikes' in an oscillograph record. We have therefore a new and very effective way of tracing the intricate pathways from cell group to cell group in the cerebral cortex as well as those between the cortex and other parts of the nervous system. In this volume the application of the method to the study of the pre-central area is described by Warren McCulloch, who has worked in close collaboration with Dusser de Barenne and is now the chief exponent of his ideas.

This is the most recent method of tracing cerebral connexions, but the study of the motor area has progressed on many other lines. To deal with them the editor has assembled a team of neurologists, each of whom is an expert in his or her field (for Sarah Tower, Marion Hines and Margaret Kennard have contributed some of the most interesting chapters). The structure, pathology, somatic and autonomic functions are all dealt with, and the editor describes the results of his own operations on the motor area in man.

The volume gives a clear survey of work which is rapidly filling in the blank spaces and giving fresh detail to the neurologist's picture of this part of the brain. It may be that the picture when completed will not be much more than an elaborate railway guide with all its maps and time-tables, and we may not be much nearer to an understanding of the way in which the rest of the brain makes use of its motor area. But this could be said of most neurological research nowadays. It does not make the picture less necessary, and it does not lessen our gratitude to the editor and to the University of Illinois for such a valuable monograph.

E D ADRIAN

RUSSIAN APPRECIATION OF THE NEWTON TRICENTENARY

Isaac Newton 1643-1727

The Third Centenary of his Birthday. Symposium edited by S I Wawilow. Pp 437. (Moscow and Leningrad Academy of Sciences of the USSR, 1943) 25 roubles.

THIS book, containing eighteen articles, each concerned with a different aspect of Newton's work or influence, is an important contribution to 'Newtoniana'. Being written in Russian, it is not easily accessible to English readers. The nature of these articles and their total bulk make it impossible in a review to do more than list and classify them, and to indicate some of the more interesting or outstanding features.

First, however, the title "Isaac Newton 1643-1727" calls for comment. The date 1643 is based on the new or Gregorian Calendar which was introduced into England in 1752, twenty-five years after New-

ton's death. According to the old or Julian Calendar Newton was born on December 25, 1642.

The collection is edited by S I Wawilow, a great authority on Newton in the U S S R. He has recently published a book on Newton and translated "Optics" into Russian. A characteristic common to all the articles in the symposium is the profound admiration for and understanding of Newton's work shown by the contributors. But the articles are confined to eulogisms or to the giving of information. Each is a study in criticism and interpretation.

Some of the articles, particularly those dealing with the progress of Newtonian philosophy in Russia, with Newton's influence on the development of European thought, would be of a particular interest to an English reader. Such is the article by T Kravetz, in which he traces the progress of Newton's views in Russia. In the minutes of a meeting of the newly founded Russian Academy of Sciences held on November 13, 1725 (the first to be recorded) an account of a disputation held about Newton's work on the figure of the earth. During the following year there were public lectures devoted to the position of the natural philosophy of Newton. From this date Newtonian mathematical methods were taken over and developed by such outstanding mathematicians as L Euler and the brothers D'Alembert and Nicholas Bernoulli, at that time attached to the Russian Academy. At a slightly later date the outstanding Russian man of science, M V Lomonosov (1711-65), was influenced in some degree by Newton but the greatest development took place in the nineteenth century when Newton's views passed into the main stream of European scientific thought. It is interesting to note that D I Mendeleev was greatly influenced by Newton and even called his hypothetical proto-element 'newtonium'. A new phase of Newtonian study began during the present century, especially after the appearance of an excellent Russian translation of the "Principia" by A Krylov in 1916 and "Optics" by S I Wawilow in 1927. The account of the progress of Newtonian studies in Russia is continued in the article by T Ramov, in which the author deals mainly with certain aspects of scientific work of M V Lomonosov, D I Mendeleev and A N Krylov, and traces the development of the mechanistic interpretation of natural phenomena. The influence of Newtonian philosophy on French thought, and especially the conflict between the Cartesians and the Newtonians, is very ably discussed by A D Lublinskaja. To take a wider view, A M Deborin traces the influence of Newtonian ideas on the development of European philosophy and culture in relation to the changing social background. The important position of Newton as the transformer of the Newtonian structural scheme into a genetic scheme is emphasized, and is linked up with the evolutionary idea which became so prominent in the nineteenth century.

The articles dealing with the scientific aspect of Newton's work are probably the most important in this symposium, but only a list of their titles can be given in this review. They are as follows: A Krylov, Sir Isaac Newton and his role in science; S I Wawilow, ether, light and matter in Newtonian physics; G G Shussarev, Newton's works on geometrical optics; I A Khvostikov, Newton and the development of the theory of refraction of light in the atmosphere; N I Idelson, the law of universal gravitation and the theory of the motion of the moon; L N Sretensky, Newton's theory of tides and

ure of the earth, A D Dubiago, the comets and their significance in the general system of Newton's "principia". The same, unfortunately, must be done with the mathematical articles, which are as follows:

N Luzin, Newton's theory of limits, S Y. Luria, Newton's forerunners in the philosophy of the infinitesimals, N G. Tschebotarow, Newton's polygon and its role in the present development of mathematics, M V. Kirpichev, Newton and the theory of similarity.

Finally, there are three articles, which cannot be assimilated with the others. One, by P M Dulsky, on the existing portraits of Newton. Another, by Y Luria, on Newton as an historian of antiquity, a most interesting article giving a detailed account of Newton's work on chronology and criticism of the aptitudes, and discussing the importance of this work in the development of historical science. Finally, there is a very vivid account by E Ch Skrijnskaia of Newton's life and work in Cambridge. The author records the influence of Barrow's teaching on the development of Newton's thought, and after discussing the Cambridge environment, raises the question: How much did Cambridge contribute to Newton's development? This question, she suggests, could really be inverted and put this way: How much did Newton contribute to the development of Cambridge? "The answer is self-evident. Newton brought to the University the glory of being the latest scientific centre, Newton raised the University to an unprecedented height of scientific achievement by the mere fact that he was there—a student, fellow of one of its Colleges and its professor. Really, it was from this Cambridge retreat that the world received the greatest achievement of human thought, it was here indeed that in a modest room of study was written the 'Mathematical Principles of Natural Philosophy'." The words of its author flared with such brilliant light that even now, two and a half centuries after Newton was associated with Cambridge, this University has neither lost nor diminished its brilliant reputation—the source of great and progressive ideas in natural science and mathematics."

S I TOMKEIEFF

A THEORY OF TELEPATHY

Telepathy

Outline of its Facts, Theory and Implications
Whately Carington. Pp xiii+176 (London: Methuen and Co, Ltd, 1945) 12s. 6d net

THE timely appearance of this volume is an indication that the more serious among experimental psychical researchers are beginning to feel the necessity of fitting the facts they have so far amassed on telepathy into a theory which may at least be able of stimulating further thought, if not of explaining some of the facts which seem to them indisputable.

Mr Whately Carington sets out by briefly summarizing the results of earlier experiments, and shows how development has proceeded in a direction in which statistical analysis has played an increasingly important part. He then passes on to a consideration of the objections and resistances which have been encountered, although in this section he seems rather too much inclined to attribute the hesitancy of scientific men to accept the findings of themselves and others to "a fear of finding something

they cannot explain away" (p 42), or to a haunting fear that the facts, if confirmed, might "weaken the status of Causality and Law" (p 44).

It is in Part 2 of his book, however, that the author embarks on his theoretical treatment, which must prove of considerable interest both to psychologists and philosophers. Briefly stated, Mr Carington's view of the mind seems to approach that held by Bertrand Russell, and lies in the direction of a theory that the 'mind' consists solely of *sensa* and images, which are "real entities existing in their own right". These constituents he calls 'psychons', and each mind consists of clusters of these psychons gathered around certain nuclei, the moods, etc., within each individual mind being considered as smaller and weaker clusters grouped around other nuclei. Thus in Mr Carington's view the mind is really a kind of system of psychons held together by associative linkages, and it is in this idea of *association* that he sees a fruitful theory developing, which, he thinks, will go far to explain such phenomena as telepathy, extra-sensory perception, and so forth.

The basic principles of this law of association are easy to grasp and, as Mr Carington says, have the merit of simplicity as well as of close connexions with psychological processes already fairly well known. Thus if two ideas, *A* and *B*, are presented together, or in close succession, to any mind and later one is re-presented, then the other is more likely to accompany or follow it than if they had not been so previously presented. In telepathy, an idea *A* may be associated with an idea *K* in the mind of the experimenter or agent; then, if *K* is presented to the percipient's mind, *A* is more likely to come into it than it would be if *A* had not been associated with *K* in the mind of the agent.

In his account of his theory, Mr Carington shows how many of the facts become more easily explicable if it be used, and how later research may amplify and modify his basic conception of it. Nevertheless, he does not hesitate to discuss such problems as survival in the light of his ideas regarding the stability of the psychon systems under post-mortem conditions. Recognizing that such systems might be imagined as persisting after the death of the body, he sees very clearly that the problem of their stability is crucial. What guarantee, he asks, have we that they will stick together and not disintegrate when the influx of sensory stimuli ceases? The question of the breakability or otherwise of the links in each psychon system must determine the survival or disintegration of each personality after death. To suppose such breakability to be a fact would, Mr Carington insists, be a conception "much too material and quite illegitimate", and, moreover, contrary to every indication. Yet this was precisely the suggestion put forward forty-one years ago by Dr Walter Leaf when reviewing Mr W H Myers' great work on "Human Personality". Much of the evidence from trance mediumship suggests it. Dr Leaf postulated the existence of surviving 'memory groups' undergoing a slow process of dissolution, and indeed he declares that, judging from the history of the various mediumistic trance personalities, their mental attitude "seems distinctly to point to the cluster of memories disintegrating—full of the gaps and vaguenesses which we should expect to find as the forerunners of ultimate dissolution."

However this may be, the present contribution to the theory, as apart from mere presentation of experimental data, is to be welcomed, and doubtless will

not only excite much controversy among those at present in the field, but also stimulate others to take a more serious view of what is one of the most exciting and intriguing problems involving, as it does, psychological, philosophical and religious speculation

E J DINGWALL

AMERICA'S MINORITY PROBLEM

The Navaho Door

An Introduction to Navaho Life By Alexander H. Leighton and Dorothea C. Leighton Pp xviii+149 +36 plates (Cambridge, Mass. Harvard University Press, London Oxford University Press, 1944) 22s. 6d net

DRS A H and D C. LEIGHTON are deeply concerned that the United States may be truly prepared to play the great part which she inevitably must in building international peace, and they see clearly that this preparation must begin at home "We cannot hope to be on proper terms with Russians, Argentinians, Peruvians, British and Chinese, if we are unable to understand the cultural groups who are much more easily within the range of our comprehension." By a happy chance, the Navaho Indians, whose reservation lies in the States of Arizona, Utah and New Mexico, came to their attention, and they decided to live and work among them, and try to see things through Navaho eyes. This book is a measure of their success, and is a notable contribution to the sympathetic understanding and fair treatment of the Indian. "It was obvious that we could not study all the world, but we could study the Navahos," and they did so in the hope that the principles which they learnt might have an application to a much wider circle. It is natural, in a book written by physicians, that much space should be devoted to medicine, but this, not less than the remainder of the book, will be of value to the anthropologist and of interest to the general reader.

Owing to the accidents of history, there came a time in the nineteenth century when the Navahos were outcasts and every man's hand was against them. Finally they came to terms with the U.S. Government, which established them on their reservation and put them under the enlightened administration of the Indian Service, but even then their troubles were not ended. There are always white men who are ready to take the Indian's land and exploit his labour, excusing themselves on some fair-sounding pretext, and the Government has not consistently set its face against political pressure designed to this end. The danger is not past, and to counteract it is one of the objects of the book.

The most illuminating parts of the chapters on medical treatment and education are the specimen speech on health and the examples of interviews with Indians suffering from various diseases, which give an insight into the way in which the medical man must approach these matters if he is to get any response from his patients. Great emphasis is laid throughout on the help which can be got from native religion and the methods of treatment which are so intimately bound up with it. One chapter is devoted to the life-stories of three Navahos, told as nearly as possible in their own words. The remaining chapters, on history, environment and society, religion, the Indian Service, and future prospects, are informative and sufficient to give a background to the main pur-

pose of the book, but anthropologists must not expect full and detailed descriptions of customs and material culture like, for example, the works of Leslie White the Pueblos. The production of the book leaves nothing to be desired, the illustrations are superb.

In spite of the poverty of much of the land on the reservation and the uncertainty of the harvests, the Navaho population has increased threefold under the Indian Service. The head of this service, the Commissioner of Indian Affairs, at whose request the book was written, pays handsome tribute in a foreword to the practical help which its administrators have already received from the Leightons' studies, and workers in other fields will doubtless derive a benefit from them.

G H S BUSHNELL

SOME TICKS OF NORTH AND CENTRAL AMERICA

The Argasidae of North America, Central America and Cuba

By R. A. Cooley and Glen M. Kohls (American Midland Naturalist, Monograph No 1) Pp v+141. (Notre Dame, Ind. American Midland Naturalist, University of Notre Dame, 1944) 2 dollars

THE Argasidae are an important family of ticks and several of their species are of medical and veterinary significance. In so far as the North American kinds are concerned, five species *Ornithodoros* are proved carriers of the spirochaetae of relapsing fever. Rocky Mountain spotted fever has been experimentally transmitted by *Ornithodoros parkeri* and *O. hermsi*. *Argas persicus* is a widespread notorious pest of poultry; the birds may become weakened owing to loss of blood and, when large numbers of ticks are involved, the effects often cause death of the hosts. This tick may also be the carrier of avian spirochaetosis, at least in Texas. The spinose ear tick of cattle, *Otobius megnani*, is a serious enemy of young animals in particular, causing much irritation and loss of condition. This species, however, has not been shown to be concerned with the transmission of any specific disease organisms.

Messrs Cooley and Kohls' monograph is a competent taxonomic study of the species affecting the area under consideration. The classification of ticks beset with difficulties and not the smallest of them, as the authors point out, the lack of adequate characters upon which the genera are to be founded. So far, no genera have been synonymized, but with the increasing numbers of new species that are being discovered it has become more and more difficult to separate the genus *Argas* from *Ornithodoros*. This difficulty has resulted in the authors meeting it by modifying the diagnoses in the two genera just quoted. Host specificity varies a good deal among different species and a surprising number of North American kinds have been found on bats. The authors recognize four genera of Argasidae, and include at least twenty-five North American species. Two of these species belong to the genus *Argas*. *Ornithodoros* includes nineteen species and there are two species each in *Otobius* and in *Antricola*.

Wherever possible, descriptions are given of the adult, nymph and larva in each case. A classified list of hosts is given together with a glossary of the terms used and a bibliography. The work is illustrated by fourteen plates and fifty-seven text-figures (including maps).

TELEVISION—PAST AND FUTURE

AS we are able to look forward to conditions of peace in Europe, it is natural for our thoughts to turn towards the resumption of many of the amenities of civilized life, which has been so seriously restricted during the War. Among these amenities is the reception of television programmes for instructional and entertainment purposes, a service which was provided by the London Television Station over a limited area of Great Britain for a year or two preceding the outbreak of war. In view of the widespread application of radio technique to military purposes, and the outstanding advances made in various directions during the past five years, it is natural to inquire in what way and to what extent radio broadcasting and television will benefit when this technique and the personnel trained in its use are directed to the exploitation of these peace-time pursuits. It is therefore relevant to refer in some detail to an address entitled "Some Aspects of Pre-War and Post-War Television" given to the Royal Institution on March 2 by Mr H. L. Kirke, head of the Research Department of the British Broadcasting Corporation.

This address surveyed the general principles of modern television practice and the technical features and requirements, Mr Kirke also directed attention to the various problems which must be solved before certain developments and improvements, which have been foreshadowed in some quarters, can be incorporated in a reliable service for the public needs.

Picture Scanning

Whatever system is employed for the transmission of a television picture, basic necessities are the analysis of the picture or scene at the transmitting end, and its synthesis at the receiving end. Thus the picture or scene is broken down into a number of small elements, so that the degree of light or shade, or even colour, of each element can be transmitted independently and reassembled in the correct order at the receiving end. The degree of distortion of the picture, or its complement the definition, will depend upon the number of elements into which the picture is divided, and the size of the resultant received picture as it appears to the eye of the viewer.

The usual arrangement for scanning a picture is to divide it in effect into a number of horizontal lines, each of which is scanned or seen by the television apparatus, element by element, usually from left to right. The scanning of a picture in this way can be visualized by imagining it to be divided into a number of strips, the right-hand end of one strip being joined to the left-hand end of the strip below to form one continuous strip. This strip can now be considered as passing a slit through which elements of the picture are exposed to a photo-electric cell as the strip passes by. The current output from the photo-electric cell at any instant is a function of the average amount of light falling upon the cell at that instant, so that the definition in the horizontal plane depends upon the size of slit or aperture, while the definition in the vertical plane is a function of the line width and therefore of the number of lines. When the scanning is done with a square or round aperture, the definitions in the vertical and horizontal directions are the same, and this is the usual arrangement. For the transmission of moving pictures, the whole field of view must be repeatedly scanned at a rate exceeding

twenty-five pictures per second, in order that the eye shall not be conscious of flicker, a condition corresponding to practice in cinematography.

The sharpness or definition of a picture depends upon the number of elements into which it is divided for scanning purposes, and the radio-frequency band width occupied by the transmission of a picture depends upon the number of picture elements per second. The London Television Station at Alexandra Palace, before the War, transmitted pictures divided into 405 lines at the rate of twenty-five pictures per second, and these occupied a radio-frequency channel of 5 megacycles per second wide. By the use of a device known as interlaced scanning, it is possible to transmit a 405-line picture with only twenty-five complete pictures per second in such a manner that the flicker corresponds to fifty pictures per second. Interlaced scanning is achieved by scanning alternate lines of a picture in sequence followed by the scanning of the remaining intermediate lines. The repetition rate or flicker frequency is therefore twice the actual number of complete pictures per second. Thus alternate 'frames', as they are called in Britain, consist of 202½ lines each, while a complete picture of two frames comprises 405 lines. Interlace ratios other than two are possible but not usual in black and white television.

Electron Cameras

Although mechanical scanning systems have been developed and may still have possibilities, the more usual method makes use of a beam of electrons for the scanning process. The picture or scene to be transmitted is focused on a plate which comprises a mosaic of minute photo-electric cells, each of which acquires a positive charge to an extent depending upon the amount of light falling upon it. A beam of electrons is caused to traverse this mosaic in the scanning process, and at every point the current in the beam is proportional to the amount of light falling upon the corresponding photo-electric element. The resulting electric impulses are used to modulate the radio-frequency carrier wave of the television transmitter. The electron camera tube, particular versions of which are known as the 'emicon' in Britain, and the 'iconoscope' in the United States, is thus the link that converts the visual picture into electric signalling impulses. There have been a number of developments in electron devices and electron optics both in Britain and in the United States during and before the War which will undoubtedly be of considerable value in the further development of television camera tubes, and it is to be hoped that the considerable development of miniature components will enable the size of mobile television cameras to be reduced, as well as the size of apparatus for use in connexion with outside broadcasts.

Reception

At the receiving end the impulsive modulation is extracted from the incoming carrier wave, and used to vary in some way the intensity of light falling upon the viewing screen. The most widely used method of display before the War was the cathode ray tube, and it is probable that for a considerable time this will prove to be the cheapest and most popular form for home-viewing. The amount of development and the knowledge which has become available during the War will undoubtedly be of assistance in the improvement of the performance of cathode ray tubes, and

mass production methods should be effective in reducing the cost

The main limitation of the cathode ray tubes is the size of pictures which can be obtained. Pictures ranging from 5 in. $\times$ 4 in. to 10 in. $\times$ 8 in. were normally obtainable in commercial receivers, the former on cheaper sets and the latter on the more expensive sets. Even larger tubes have been made and used, and it is of interest to note that one firm in the United States has advertised that cathode ray tubes suitable for pictures nearly double that size will be available after the War. Whether these will be a commercial proposition remains to be seen. For large-screen operation a number of methods have been used. Most of these employ some form of small cathode ray tube with high intensity beam and a fluorescent screen from which the picture is projected on to a larger screen. Such devices have the disadvantage of being more costly and require very high voltages for their operation.

Programme Distribution

Now, it has already been explained that the radio-frequency band-width required for an effective television transmission is about ± 2.5 Mc/s., as compared with ± 10 or 15 kc/s. for good-quality sound broadcasting. To transmit the larger band required for a medium definition television system necessitates the use of a carrier frequency in the neighbourhood of 50 Mc/s., corresponding to a wave-length of 6 metres. The use of such a short wave-length restricts the range of reliable reception to some 30–50 miles, depending upon the height of transmitter and receiver and the existence of intervening hills, trees and buildings. With such a limitation on the range of transmission, it is clearly necessary to have several transmitting stations if the programmes are to be received in various parts of Britain.

The problem of communicating programmes from one station to another has received considerable attention, since the use of ordinary telephone cables to transmit the wide band of frequencies required is not very practicable. Special co-axial cables have been developed for this purpose, and preliminary work has also taken place on the use of radio links for point-to-point transmission. In each case, however, it is necessary to have amplifiers or repeater stations at five to thirty miles apart, so that the problem of relaying programmes over a distance of four hundred miles, such as from London to Glasgow, is quite a formidable one. Both cable and radio link methods had, however, been in successful use in Great Britain before the War, for supplying outside broadcast television features from a mobile transmitter developed by the B.B.C.

Future Developments

There is no doubt that a high-definition television system can be developed, and it would be possible to provide a service for the whole of Great Britain by such a system. Whether this could in fact be done is mainly an economic question. The cost of television programmes is many times that of sound programmes. The cost of television transmission apparatus is considerably greater than that for sound. The number and cost of technical, operational and programme staff is also considerably greater. The cost of distribution, whether by line or radio, will also be greater, and last but by no means least, the cost of the receiver is perhaps one of the most important factors.

Higher Definition

Mr Kirke then discussed the question of the definition that is satisfactory for a television service, particularly in connexion with the possible future increase in size of picture for home-viewing. The present American system uses 525 lines and 60 frames per second, but the resulting increase in band width is accommodated in about the same frequency channel of 4–5 Mc/s. by the use of asymmetric side-band transmission. It is doubtful, however, if it is worth while considering an alteration in the British system unless a change is made to 600, or even 800 lines with a corresponding increase in horizontal definition. In any event, much experimental development work is required, and it cannot be expected that any new system can be made available as a public service for several years after the end of the War.

One aspect of the subject that may settle the future trend of development is that of the size of picture required for normal home-viewing. At present this size is limited to 10 in. $\times$ 8 in., but it seems reasonable to anticipate the desirability of increasing this to 20 in. $\times$ 16 in. For the same viewing distance this will involve an increase in the definition in both the vertical and horizontal directions, and the resulting increase in scanning speed will require a band-width four times as great as at present. The carrier frequency will have to be correspondingly increased to at least 200 Mc/s., a wave-length of one and a half metres or less. The propagation characteristics of such short wave-lengths have certain disadvantages from a general reception point of view: the effect of ground contours and the shadows of hills and trees are more marked, and interference effect by waves reflected from buildings and other objects are more severe. Also, in general, the sensitivity of receivers would be less and the cost probably greater, although by development and mass production this cost might be reduced.

Colour

Demonstrations have already been given in Great Britain and in the United States of the possibilities of transmitting pictures in colour, which requires the use of two or more basic colours. At the transmitter filters can be used to separate the colours. In a mechanical system, as used in the United States, a rotating set of colour filters permits the projection of the various colour elements of the scene in turn on one photo-electric screen. The pictures contain the different colour elements are each scanned, and in some cases there is interlacing of the different colours. At the receiving end a similar rotating colour disk is used in conjunction with a cathode ray tube. In the electronic system demonstrated by Mr J. L. Baird in Great Britain, a two-colour and a three-colour process have been used experimentally. In effect, a separate screen is used for each colour, each screen being scanned by a separate electron beam. In colour television the total number of pictures transmitted per second must be increased as each colour requires a separate scan, and the increase in number of pictures per second requires a proportional increase in band-width. If the practical limit is the band width employed, it is necessary to compare the advantages of colour with the disadvantages of low definition.

There is no doubt that colour does give a considerable improvement to the picture. It appears to add another dimension, and provided a certain standard of definition is achieved in any event, then colour is a

great advantage. This is the experience of those who have experimented with colour photography, and it is certainly true of the cinema, although there are still many who say they prefer black and white.

If it be assumed that for a three-colour system the total number of pictures per second is doubled instead of trebled, then double the band-width is necessary. If the band width is 10 Mc./s., corresponding with 800 lines for monochrome, then a colour picture could be produced having 565 lines approximately; and a decision as to which was the better would be difficult, for a 565-line picture with colour would give an agreeable degree of definition and a pleasing result.

This point was demonstrated by Mr. Kirke by displaying two still pictures obtained in the United States about a year ago and taken with a mechanical colour switching system using 375 lines and 120 frames per second, the whole picture being accommodated in the standard American band-width of 4 Mc./s. The 375 lines in colour therefore correspond with 525 lines in monochrome: the pictures show that the apparent definition is rather surprising, and the compensating effect of colour is quite noticeable.

FORMATIVE EFFECTS OF ENVIRONMENTAL FACTORS AS EXEMPLIFIED IN THE DEVELOPMENT OF THE ONION PLANT

By DR. O. V. S. HEATH

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DURING the last two decades, discoveries of great importance have been made in the field of plant morphogenesis, and the predominant part played by the external factors of day-length and temperature has been established. Applications of this knowledge to the control of plant growth in agricultural and horticultural practice have led to important results, for example, in the forcing of bulbs (Blaauw, Van Slogteren and their associates^{1,2}) and the development of vernalization as a practical technique in the U.S.S.R.^{3,4,5}. In both these cases temperature effects are concerned; with regard to the length of day effects ('photoperiodism') the ample empirical knowledge we owe to Garner and Allard and subsequent investigators⁶ has so far yielded fewer practical results than might have been anticipated. The work dealt with in this article has brought to a focus these lines of research in an attempt to elucidate the behaviour of the onion plant.

The physiological investigation of the onion plant in this Institute began five years ago with the primary object of discovering the causes of 'bolting' (flowering) in onions grown from sets and the most satisfactory methods of control. As the work has developed, investigations on the mode of production, storage and use of onion sets have been carried out. The practical recommendations arising from this work are being dealt with elsewhere; the present account is concerned with the physiological effects of the factors of day-length and temperature, and their interactions, in controlling the developmental morphology of the onion plant—especially the processes of bulb formation, and flower initiation and development.

Onions are grown in practice from seed sown in the open, from transplanted seedlings, or from sets.

The latter are small bulbs, produced from seed in one season, stored dry through the winter and planted out in a second season to give a usable crop of large onions. Before the War, considerable quantities were imported, mainly from southern Europe. Their chief disadvantage is their marked tendency to bolt; the bulb produced is then generally small and of little value. In this work, therefore, the practical interest centres on preventing flowering, rather than hastening it as, for example, in vernalization. Bolting may be prevented in a number of ways, but there is little doubt that the most practical method lies in the use of suitable varieties^{7,8} and sets of suitable size^{7,8,9}. Selection of low-bolting strains has been carried out⁸ and re-selection work is being continued.

To provide a background for discussion, a brief description will first be given of the normal life-history of an onion plant, covering the whole growth and development from seed to mature harvested bulb, through two growing seasons and the intervening storage period; some of the experimental results will be intercalated as seems appropriate. Except where other references are given, the whole account is based on our own observations; but the development of the seedling (before bulb development) has also been described by Hoffman¹⁰ and that of the flower by Jones and Emsweller¹¹.

Development from Seed to Set

At germination of the seed the cylindrical cotyledon emerges, and through a pore near the bottom the first foliage leaf later protrudes. Each foliage leaf in turn emerges through a similar pore in its predecessor; the pore thus marks in each leaf the junction of the cylindrical leaf 'blade' and the cylindrical sheathing leaf-base. During development, the first formed portion of the leaf initial gives rise to a pointed structure, the embryonic leaf-blade. This expands both longitudinally and centripetally, over-arching the axis; at the same time the embryonic leaf-base extends round the growing point and completely surrounds it at a very early stage. The pore is thus left on the side of the axis opposite the tip of the leaf blade, and as the phyllotaxy is alternate, is thus in the correct position for the emergence through it of the next leaf in succession (Fig. 1). The leaf blade is at first solid, and only becomes hollow after emergence by the formation of a lysigenous cavity.

Before the onset of bulbing, new leaves emerge about once a fortnight, at ordinary summer temperatures, and there are generally three unemerged leaf initials to be seen at the growing point on dissection (Fig. 1). Under short-day conditions (less than about twelve hours) the plant can apparently continue growing and producing new leaves indefinitely in this way without bulb formation. The older leaves die off; the pseudo-stem or neck, formed of thin concentric leaf-bases enclosing a practically solid core of growing leaf-blade, becomes gradually thicker and longer; the short basal stem tends to rot away below but grows gradually at the upper end, where new adventitious roots emerge. After a time (eighteen months of artificially shortened days in one experiment) an inflorescence emerges; further leaf production is then carried on by an axillary bud: this mode of growth without bulb formation has continued for more than three years in the experiment cited.

Under natural conditions, however, the day-length ultimately attains a critical value at which a bulb begins to form; that this is a response to the

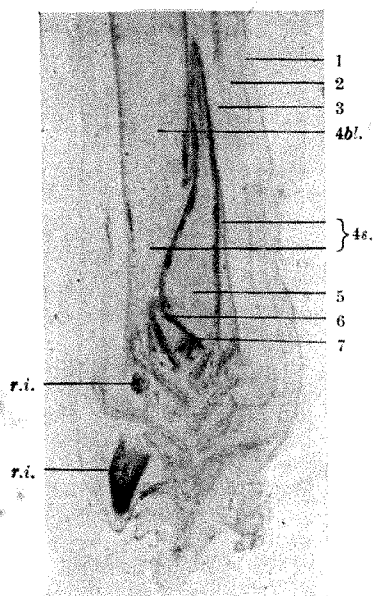


Fig. 1. LONGITUDINAL MEDIAN SECTION OF A 4-LEAVED ONION SEEDLING BEFORE BULB DEVELOPMENT. $\times 12$. LEAF NUMBERS: 1 TO 4, EMERGED LEAVES (4b1., BLADE; 4s., SHEATH); 5 TO 7, UNEMERGED LEAF INITIALS; r.i., ROOT INITIALS.

stimulus of long days is well established^{7,12,13,14,15}. The critical day-length varies for different strains of onion between about twelve hours and sixteen hours¹³ at ordinary temperatures. The effect of temperature on the photoperiodic requirements of seedlings is similar to that described below for plants grown from sets. With the onset of bulbing the sheathing bases of one or more of the *innermost of the emerged leaves* begin to swell, and this is either accompanied or followed by the swelling of the sheaths of usually three of the *outermost unemerged leaf initials*. This swelling occurs by increase in cell size and development of intercellular spaces, and without cell division.

When these unemerged initials swell to form bulb-scales they apparently suffer some irreversible change, for they lose the capacity ever to develop a leaf-blade, and this also applies to one or two of the adjacent unswollen initials. Furthermore, it has been found that when definite bulb development occurs, the emergence of further leaves normally ceases, immediately or soon according to the temperature^{9,14}. This observation has proved of the greatest value in accounting for the behaviour of the onion plant under various conditions^{14,16}.

Although no more leaves emerge after onset of bulbing the production of leaf initials at the growing-point goes on very rapidly until there are about nine unemerged leaves, of which the outermost 2-4 are swollen (Fig. 2). Some 4-6 of the unswollen leaf initials are available to produce foliage leaves in the next growing season; this number varies but little with set size¹⁷ and hence the higher yields obtained with large sets, in the absence of bolting^{7,8}, is due to large size of parts rather than to a greater number of leaf initials ready for emergence¹⁷.

In this condition the neck of the onion plant collapses, the leaf blades falling over on to the ground while several of them are still green and turgid. This collapse can occur with abundant soil moisture, though hastened by drought, and is due to the cessation of emergence of new leaves at bulbing. When the blade of the last leaf has fully emerged,

the neck no longer has a solid core (as in Fig. 1) and thus becomes a thin-walled hollow tube formed of concentric leaf-bases. This tube readily buckles under the weight of the green leaf-blades, especially in wind or drought¹⁶.

Following the collapse of the neck the leaves die and the bulb enters upon a dormant period, which can also occur with plentiful soil moisture; if the bulb has been kept small by late sowing and close spacing it now constitutes an onion set, which is normally lifted and stored dry through the winter.

The processes of bulb development and ripening normally follow the course outlined above, once bulbing has begun. But if plants that have recently begun to form bulbs are again subjected to short days, although some individuals complete their bulb development and ripen satisfactorily, in others the process of bulbing is arrested and the emergence of new leaves begins again, some of these leaves then showing transitional forms between true foliage leaves and bulb scales; lowering the temperature may have similar effect. There thus appears to be a critical stage in bulbing beyond which the process becomes irreversible. The practical interest lies in the similar reversal of the bulbing process which sometimes occurs, under field conditions during August or September, in onion plants which have bulbed late owing to very late sowing or low temperature. The longer the harvest of such plants is delayed the worse they become.

Development during the Dormant Period

With ripening, activity at the growing point almost ceases; during storage at ordinary temperatures only one to two more leaf initials are formed, and these mainly during the latter part of the winter¹⁷. Then, in March or April, the central axis bearing the terminal growing-point begins to elongate, as the first stage in the development of a scape. At the same time a spathe develops, and a lateral bud appears in the axil of the last leaf initial (Fig. 3). This stage of inflorescence development seems to be reached rapidly, but no further development occurs until after the set has been planted out.

Inflorescence initiation only occurs in bulbs above a certain size which varies with the variety of onion and is of the order of 2 gm. weight or 1½ cm. diameter. Inflorescence initials have only been found where a

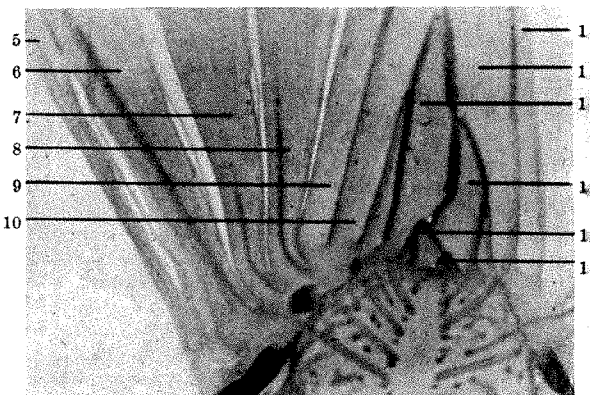


Fig. 2. LONGITUDINAL MEDIAN SECTION OF AN ONION SET IN THE VEGETATIVE CONDITION. $\times 8$. LEAF NUMBERS: 5, EMERGED, UNSWOLLEN; 6, EMERGED, SWOLLEN BASE; 7, 8, UNEMERGED, SWOLLEN BASES (BULB SCALES); 9, 10, UNEMERGED, UNSWOLLEN BASES (BULB SCALES); 11-15, UNEMERGED INITIALS (NEXT SEASON'S LEAVES).

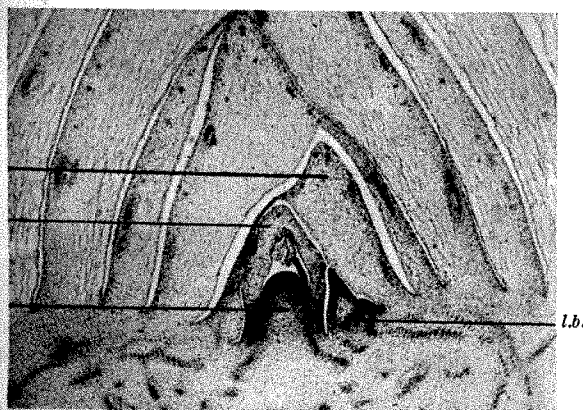


Fig. 3. LONGITUDINAL SECTION OF AN ONION SET AFTER INITIATION OF AN INFLORESCENCE. $\times 10$ APPROX. *l.b.*, LATERAL BUD; *sc.*, SCAPE; *sp.*, SPATHE; *l.i.*, INNERMOST LEAF INITIAL.

total of at least thirteen leaf initials has been formed at the growing point¹⁷ and this may represent the stage of 'ripeness to flower'¹⁸. The mode of operation of this 'size effect' is under investigation.

When inflorescence initiation occurs in a bulb as described above, the plant has necessarily been exposed to long days to enable a bulb to form. The flowering of plants kept in short days throughout, described earlier, shows that at no stage of ontogeny are long days (> 12 hours) essential either for initiation or emergence of inflorescences. Short days ($< 16\frac{1}{2}$ hours) have similarly been found to be inessential.

Development from Set to Mature Onion

When the set is planted out, the eight or nine swollen leaf initials begin to elongate, all except the outermost one or two having leaf-blades; the swollen scales shrivel and later rot away. During a period of about a month at ordinary temperatures three or four leaf-blades emerge in rapid succession. Hereafter the leaves emerge in serial order about once a fortnight. In due course, in the absence of bulbing and if the set was large enough to have formed an inflorescence initial, the inflorescence merges from the sheathing base of the last leaf.

Under long-day conditions, however, renewed bulb development occurs. The critical day-length for plants grown from sets is almost certainly lower than for seedlings¹⁴, which perhaps accounts for the earlier crops from sets¹⁹. For a given day-length, bulbing is accelerated by high temperature and greatly delayed or prevented by low temperature^{7,14,15}; thus at lower temperatures longer days are needed. There appears to be a minimum time-lag of about three weeks between the first application of the long-day stimulus and the first external appearance of bulb development ($21-27^{\circ}\text{C}$. and $16\frac{1}{2}$ hours).

If conditions are such as to produce early and rapid bulbing, inflorescence emergence is suppressed¹⁷. This appears to be a consequence of the stimulus to bulb formation, for at temperatures low enough to prevent or greatly delay bulbing, long days actually accelerate inflorescence emergence¹⁵. The acceleration is thought to be brought about mainly by a great increase in the rate of scape elongation, associated with more rapid emergence of the surrounding leaves; inflorescence initiation is apparently independent of day-length¹⁵. This effect of long days on elongation of the scape resembles their effect on the 'shooting'

of spring cereals²⁰. It would appear that long days always promote cell extension in the onion plant. At moderate and high temperatures long days promote radial extension (bulbing) and limit longitudinal extension (emergence of new leaves and inflorescences); at lower temperatures such longitudinal extension is enhanced and radial extension inhibited.

Since long days combined with high temperatures prevent inflorescence emergence, late planting of sets in the field should reduce bolting, and this actually occurs⁸. Unfortunately, this advantage of late planting is more than offset by the great reduction in yield⁸, which is probably mainly due to the reduced leaf area caused by the cessation of leaf emergence with rapid bulbing. The small yields often given in warm seasons in Great Britain by 'early' strains of American origin, which are likely to have a low photoperiod for bulbing, may be similarly explained. Conversely, the large bulbs commonly produced by autumn sowing or spring sowing under glass may be attributed to the large leaf area produced before bulbing puts an end to the emergence of further leaves. The effects of day-length^{13,14} and temperature¹⁴ upon ripening intensify those upon bulbing onset.

Very high temperature ($21-27^{\circ}\text{C}$.) during the second season's growth not only prevents flowering by accelerating bulb development; it also exerts a direct effect even in the absence of bulbing (short days), suppressing both inflorescence initiation¹⁵ and the emergence of initials already present¹⁷. Such suppression without bulb development is unlikely to be of importance under field conditions in Great Britain, since high temperatures seldom occur except during the long days of summer.

Further Temperature Effects

Some further temperature effects may now be considered. Attempts to vernalize onion seed have so far given negative results, but the exposure of the seedlings to relatively high temperatures (mean about 21°C .) throughout the first season's growth results in sets which do not form inflorescence initials in the following spring¹⁷ and fail to flower when planted^{9,14}. In the data so far obtained this effect is, however, inseparable from a size effect, for owing to more rapid bulbing such sets are smaller than those produced at lower temperatures out of doors⁹.

The effects of high or low temperature during the whole or part of the storage period have proved somewhat complex. The effects upon flowering may be considered first. High temperature (30°C .) throughout the storage period (twenty-two weeks) not only inhibits inflorescence initiation during storage but also exerts a remarkable after-effect in preventing such initiation during the following season's growth¹⁷. Bolting may thus be almost completely controlled⁹. High temperature for the first eight weeks of the storage period also exerts an after-effect in delaying and greatly reducing inflorescence initiation and flowering; high temperature for the last eight weeks of storage, although it does delay initiation and flowering to some extent, is much less effective^{9,17}. It was deduced from indirect evidence¹⁴ that these effects of high temperature were not in the main brought about by the drying of the sets, and this has been confirmed by subsequent experimentation with controlled humidities. Cold storage (0°C .) for the first eight weeks exerts an after-effect in somewhat reducing inflorescence initiation and bolting; when given for the whole twenty-two weeks or the last eight weeks only, initiation is prevented

during treatment, but whereas in the former case subsequent initiation and flowering are reduced, in the latter they appear to be actually increased on return of the sets to normal temperatures^{9,17}. This last suggests that the onion plant is adapted to climatic conditions in which a cold spell in January–February is frequent. Greater survival in the field of sets from the late cold-storage treatment points in the same direction. The greater effectiveness of early high- or low-temperature treatment in preventing inflorescence initiation is of theoretical interest since such initiation does not begin before March.

The formation of new leaf initials during storage is also affected by the temperature, but these effects are mainly direct; the only after-effect found was a tendency for sets from treatments preventing initiation to produce initials more rapidly on return to normal temperatures¹⁷, thus resembling the effect of late cold storage on inflorescence initiation noted above.

High-temperature storage not only affects initiation of inflorescences and leaves, but also exerts remarkable after-effects in delaying bulbing and ripening^{9,14}. Such delay of bulbing allows of the emergence of more leaves¹⁴, the delay of ripening gives a longer growing season, and doubled or even quadrupled yields may result⁹. As in the case of flower initiation, the effects of early and late high-temperature storage (eight weeks) differ greatly, but here the difference is in the opposite sense: early heat treatment is almost without effect on bulbing and ripening, but the effect of late heat treatment is considerable; heat treatment throughout the whole twenty-two weeks period has a still greater effect. Recent experiments have shown that the increase in yield due to delay of bulbing and ripening is greater when drying of the sets in store is prevented by combining high humidity with the high temperature. The earlier deduction¹⁴ that these effects of heat-treatment were not due to drying is thus confirmed. The disadvantage of high-temperature storage that it causes shrivelling may apparently be overcome by the use of high humidities, but the delay of ripening which causes the increased yield may itself be a disadvantage in some seasons, especially in Scotland and northern England.

The effects of the environmental factors on flowering may be summarized as follows:

First, a direct effect of high temperature on flowering may be distinguished. Inflorescence initiation and emergence are inhibited, partially or completely, by exposure of the plants to temperatures above about 21° C., either during the whole period of growth from seed to set, during the whole storage period (October–March) or the earlier part, or throughout the second season of growth from replanted set to mature onion. The effect from seed to set may be solely due to the reduction of set size consequent on earlier bulb development; the effect in the second season is independent of day-length and hence of bulbing. When high temperature is applied during the last part of the storage period, it delays but may not ultimately reduce flowering. The effects of high storage temperature are not in the main due to drying of the sets.

Very low temperature (0° C.) throughout the storage period, or for the first part only, reduces flowering; but low temperature for the last part only results in a sudden flush of inflorescence initiation on return to normal temperature and appears actually to increase flowering. Medium temperatures

(10–15° C.) at any time during the life-history are apparently the most favourable to flowering, except for the accelerating effect of late cold storage.

On flowering, length of day has an indirect effect associated with bulbing as well as a direct effect. A temperatures high enough to encourage rapid bulbing in plants grown from sets, long days suppress inflorescence emergence; at temperatures low enough to prevent or delay bulb formation, long days accelerate the emergence of inflorescences by increasing the rate of scape elongation. The former effect of long days may thus be considered as indirect and due to the promotion of bulb development. Day-length is apparently without effect on flower initiation, and affects only the further development and emergence of the initials.

The more important effects on bulbing and ripening are these: The onset of bulbing is a response to the stimulus of long days and there is an interaction with temperature such that at lower temperature longer days are needed. Seedlings apparently need a longer photoperiod for bulbing than do plants grown from sets. At high temperatures bulb development is rapid and the emergence of new leaves ceases abruptly with its onset; at lower temperatures or on occasionally several more leaves may emerge. With a return to short days and (or) low temperature bulbing may be arrested and leaf emergence recommence without the usual dormant period. Long days and high growth temperatures not only stimulate rapid bulbing onset and development but also expedite ripening. Bulbing onset and ripening are delayed in plants grown from sets stored at high temperature, either throughout the winter (October–March) or for the last part only; heat treatment for the first part only of the storage period has little or no such effect. Such delay is increased if drying of the sets in store is prevented by high humidity.

It will be seen that a fairly comprehensive picture has been obtained of the control of development in the onion plant by the external factors of day-length and temperature. Further work is now being directed towards a more rigorous analysis of the internal rather than the external factors involved in bulb development and inflorescence initiation. The importance of such factors is indicated by the striking effect of size of set; large size is the outstanding characteristic leading to bolting, and the experimental fact that artificial reduction in size by the removal of swollen leaf bases prevents or delays bolting points the way to further progress in this analysis.

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⁵ *Imp. Bur. Plant Genetics: Herbage Plants, Bull. No. 17* (1934).

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¹⁶ Holdsworth, M., and Heath, O. V. S., *Nature*, **155**, 334 (1945).

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OBITUARIES

Prof Samuel J Record

THE death on February 3 of Samuel Record at the age of sixty-three will be keenly felt by people all over the world who are interested in wood, for, the name of any one individual deserves to be especially associated with the great revival of interest in wood anatomy during the past quarter of a century, and his. He very early realized the possibilities of the then unknown woody species of the tropics and the fundamental importance of the wood sample backed by adequate herbarium material. When, therefore, he was appointed professor of forest products at Yale in 1917, he set out to build up a collection of timbers that was to become by far the most important collection in the world. What was perhaps equally important was that he deliberately aimed at making a collection available to any genuine researcher in any part of the world. A deep and sincere desire to further the general cause of wood anatomy in any way that he could was characteristic of him and partly explains his world-wide popularity. Much as he did to this end by means of encouragement and advice must disappear with him, but he leaves more permanent memorials at least two of the instruments he used for carrying out this policy, the journal *Tropical Woods*, which he founded in 1925 and edited until he died, and the International Association of Wood Anatomists, for the creation of which he was very largely responsible and of which he was the first secretary-treasurer.

Record was an indefatigable worker, with a flair for seeing what most needed doing and an exceptional capacity for getting it done, either by his own labours or by interesting others. As examples of these talents we may cite first his books on the timbers of tropical America, the first of which, written with C D Merrill and published in 1924, marked a tremendous stride forward in knowledge of the trees and the timbers of this vast area, and secondly the standardization of the terms used in wood anatomy, for which he was largely responsible as chairman of the committee of the International Association of Wood Anatomists that ultimately achieved this end. He was always specially interested in the taxonomic aspects of wood anatomy, and his exceptionally wide knowledge of woods enabled him from time to time to make striking suggestions, particularly with regard to the position and affinities of individual genera or the botanical identity of timbers previously known only by their vulgar names, such as the tulipwood of Brazil. Record was educated at Wabash College, where he gained the M.A. degree and where he was later, in 1930, given an honorary doctorate in science. In 1915 he took the degree of master of forestry at Yale University and entered the U.S. Forest Service. In 1910 he went back to Yale and joined the forestry faculty. In 1917 he became professor of forest products and in 1939 Pinchot professor of forestry and dean of the School of Forestry. L CHALK

It is now nearly twenty-five years since I started the most interesting correspondence with Samuel J Record. The correspondence continued without interruption until the end of January this year, when I received his last letter. He had mentioned his plans for his retirement from the University, which he would be in June—how he was anticipating hav-

ing time for further research and the writing of a new book, and both he and I were looking forward to his expected visit to London, when we could again discuss matters relating to forestry, nomenclature, identification of timbers, and other subjects of mutual interest. We had much friendly controversy on these subjects, but generally our conclusions coincided. His energy and great knowledge, and the fact that he had at hand the very exhaustive collection of specimens of wood (more than thirty thousand) at Yale University, the accumulation of which was largely due to his personal efforts, was a great advantage, and from him I gained much useful information.

It was not only in his professional capacity that he excelled: he had wide interests, an active and tireless brain, a keen and subtle sense of humour, and I shall always remember with pleasure the long personal talks which cemented our friendship on the two occasions when he visited Britain.

His work "*Timbers of Tropical America*", the quarterly journal *Tropical Woods* of which he was editor, and many others were invaluable, but his outstanding work, "*Timbers of the New World*", provides much needed authoritative information about the woods and forests of Brazil and southern America, and is of surpassing value to the student of forestry and botany.

His sudden death at such a comparatively early age is a great loss, not only to his friends, but also to the world in general. ALEXANDER L HOWARD

Colonel M. J Godfery

WE regret to record the death at Torquay on April 9 of Colonel Masters John Godfery.

Colonel Godfery was a leading authority on European and especially British orchids. He carried out much research work in some of the more critical genera, including *Epipactis* and *Ophrys*. He contributed many papers to botanical journals, and in 1933 published his sumptuous "*Monograph of Native British Orchidaceae*", illustrated in colour by his wife. It will long remain the standard work on the group in Great Britain.

Colonel Godfery's most striking research related to the pollination of species of the genus *Ophrys*, much of which was carried out by watching cut flowers in vases on hotel verandahs in the Mediterranean region. He was able to confirm the observation, first made by M Pouyanne of Algiers, that certain species are pollinated by the males of insects which mistake the lip of the orchid for the female and, in performing the motions of fertilization on the lip, effect the pollination of the orchid. The male insects pay attention to the orchid lips only during a short period before the females emerge from their pupae, thereafter the orchid lips are left alone. This astonishing relationship between insect and flower has since been discovered also in an unrelated Australian orchid.

WE regret to announce the following deaths:

Dr Stanley Wells Kemp, F.R.S., secretary of the Marine Biological Association of the United Kingdom and director of its Plymouth Laboratory, on May 16, aged sixty-two.

Prof P Pelseneer honorary permanent secretary of the Royal Academy of Sciences of Belgium.

NEWS and VIEWS

Hydrographer of the Navy Retirement of Vice-Admiral Sir John Edgell, K.B.E., C.B., F.R.S.

ON April 30, Vice-Admiral Sir John Edgell retired from the post of Hydrographer of the Navy which he had held since 1932. Sir John has seen fifty-one years of service in the Navy, and had been in the Surveying Service for forty-three years. He held the post of hydrographer for longer than any other officer since Admiral Wharton (1884-1904) and had in fact done so for more than twice as long as any of his predecessors in the post save one. The work of the Surveying Service under Sir John in the major operations has been commented on again and again during the War, most notably perhaps by the late Admiral Ramsay in a report on the invaluable help given in the preparation for and the consummation of *D* day. But here it is more appropriate to refer to his interests in marine science generally. Sir John was elected F.R.S. in 1943, and was the first Hydrographer of the Navy to receive that high distinction since Sir Mostyn Field (1904-9). He has served as a member of the Port of London Authority since July 1941, and has now (it is understood) become acting conservator of the River Mersey. Shortly after he was appointed Hydrographer of the Navy, he became chairman of the Sub-Committee for Physical Oceanography of the National Committee for Geodesy and Geophysics, a position he still holds. It is well known that the "Discovery" Committee has, since its early days, had exceptionally valuable assistance from the Hydrographer of the Navy in the planning and running of its fine expeditions to high southern latitudes, and since Sir John succeeded Admiral Douglas on the Committee, his help has been very greatly valued.

Sir John Edgell also takes part in the Development Commission's work on fisheries research, and, by participation in the conferences of the International Council for the Exploration of the Sea, has become closely acquainted with foreign oceanographers. What has so far been said touches the past and the present, but it may easily be appreciated what great hopes British oceanographers have for the future, knowing that Sir John is applying his very best efforts to the end that Britain shall become possessed of a national institution of oceanography. He has already presided over meetings of scientific men working towards that goal, and prospects seem promising, largely thanks to his energetic interest, if Britain should once again take up a foremost position in the study of the sea, it will be greatly due to Sir John.

Rear-Admiral A. G. N. Wyatt

REAR-ADMIRAL A. G. N. WYATT, who succeeds Sir John Edgell, was born in 1893, being twelve years younger than his immediate predecessor. It is interesting to note that he is the first Hydrographer to enter the Navy after the withdrawal of *H.M.S. Britannia*, and, consequently, through the Royal Naval Colleges at Osborne and Dartmouth. He had the distinction of being selected as a chief cadet captain of his term, evidence that at an early age he displayed those qualities of leadership and character so noticeable in later life, and the award of the Royal Humane Society's medal for life-saving in a yachting disaster, when only in his early teens, was

indicative of his courage and powers of endurance. He went to sea as a midshipman in 1910. During the War of 1914-18, he served in destroyers and the battleship *Prince of Wales* as a watch-keeper, and, during the last year of the War, in command of a destroyer. As a young lieutenant, he was an expert boat-sailer, at which he excelled, even in a profession where a high standard of proficiency in that art was anticipated. It was not until 1918 that he decided on joining *H.M.S. Melisande* as a fourth class assistant surveyor, to devote his life to that service of which he was destined, twenty-seven years later, to become the head.

A distinctive feature in the new Hydrographer's career is his long period of service in charge of surveys at sea. He has commanded six of *H.M.S.* surveying ships, extending over a period of fifteen years, in fact, except for a spell of eighteen months as superintendent of charts at the Admiralty early in the present War, an appointment for a similar term as assistant hydrographer, he has been in charge afloat since 1926, when he joined his first surveying command, *H.M.S. Ormonde*. His hydrographic services have taken him to such varied parts of the world as Labrador, the Persian Gulf, Australia and New Zealand. During the greater part of the War, Admiral Wyatt was in command of *H.M.S. Challenger* in eastern waters. On relinquishing the command to take over his new duties, he received a letter of appreciation from the Lords Commissioners of the Admiralty for his services "in the valuable work of surveys completed under your direction since your arrival in the eastern theatre of war".

Educational Plans and Purposes

IN accordance with the general view that the study of education is a branch of sociology, *Nature* has distributed to its readers the discussions that led to the Education Act of 1944, and those that have so far resulted from that event. A new step has now been taken. The Ministry is to publish a series of pamphlets the first of which, bearing the title "The National Schools: their Plan and Purpose", has just appeared (London: H.M. Stationery Office, 1945. Pp. 6d net). Here the Ministry comes to close grips with the facts, the object of the pamphlet being "to set out some reflections relating planning to purposes in terms, not of the legal 'child', but of living children. Each kind of school is tersely dealt with, beginning with nursery and infant schools. Here, by the way, a curious *lapsus calami* attributes to Margaret Macmillan the great saying, "Educate every child as if he were your own". It was Rachel's saying, reverently quoted by her sister Margaret. The section on junior schools touches a sore spot when it remarks that far "the juniors have too often had to make do with the accommodation available after the seniors have been dealt with".

It is, however, when the pamphlet leaves the subject of primary and enters upon that of secondary education that the difficulties begin. The old identification of secondary and grammar-school education is traced to its historical causes, and blamed for unfortunate consequences. The promising junior technical schools, now in wholly insufficient supply, are explained, their vitality and successful development being attributed in part to "their freedom from the ties of any external examination". In the section on modern schools we read again that "free from the pressures of any external examination, the schools can work out the best and liveliest form

secondary education suited to their pupils" In fact, the Ministry seems to entertain definite views as to external examinations Cautious commendation is given to 'multi-lateral' experiments in organization We note, however, that in the reconstruction plans of certain counties, the letters 'G T M' frequently indicate that grammar, technical and modern education will be combined in one institution which will not be too large

Survey of Technical Education, 1944-45

IN his presidential address before the annual Whitsuntide conference of the Association of Teachers in Technical Institutions held in London, Mr C J Tirrell referred to some of the major problems now emerging from attempts to implement the 1944 Education Act in the technical field At the level of secondary education, past successful experience with junior technical schools will be of great value in the establishment of practical and realistic curricula, while the extension of the school-life under the Act to at least five years opens up a wide field of educational experiment in the technical secondary school, without prejudging the issue as to the extent to which the 'multi-lateral' idea may be applied An extension of the system of part-time day release is essential if practical experience and theoretical study are to be properly correlated, and there is an obvious need for a central council to bring together the universities, technical colleges and industry, if higher technological education is to maintain contact with industrial practice in all its stages of development Moreover, the great importance of craftsmanship to the many small industrial firms (some 100,000) seems to demand the establishment of new national certificates in craftsmanship which would ensure due attention being paid to the necessary technical background underlying all aspects of vocational training

Vocational Guidance

THE City of Birmingham Education Committee has issued a report of a research on "Scientific Vocational Guidance and its value to the choice of employment work of a Local Education Authority" The whole research, carefully and competently carried out, has extended over a period of no less than eighteen years, its general object being to ascertain what value there is in using psychological methods in aiding young entrants into industry, commerce and the professions, by showing clearly at the outset the likelihood of success or failure in certain branches of employment The report suggests that on the staff of a secondary school there should be at least one teacher competent to apply psychological tests, and that he or she should work in close co-operation with a specially qualified officer The resulting records could be used from time to time to enable decisions to be reached as to the course of a child's instruction, and towards the end of the child's school life to enable the juvenile employment officer, co-operating with the head and with the trained teacher, to give reliable vocational guidance The report, which includes the most elaborate details, may be obtained from the City of Birmingham Education Committee for 2s 6d.

British Council

Formation of Agricultural Department

AN Agricultural Department, which will be advised by a panel presided over by Prof J A. Scott Watson,

chief education and advisory officer of the Ministry of Agriculture, has been set up within the Science Department of the British Council, and Dr W T H. Williamson has been appointed director of the new Department Since the formation of the Science Department of the British Council in 1941, it has been found that many of the inquiries from abroad relate to agriculture In consequence, the Department of Agriculture has been created to control, co-ordinate and extend the work already begun in this direction Prominent agricultural scientific workers have made visits abroad under the auspices of the British Council and provided reports on the agriculture of some foreign countries It will be one of the functions of the new Department to follow up these reports and to provide expert information on how far the agricultural needs of the countries concerned can be provided for by the nations of the British Commonwealth It will present the achievements of British agriculture to other countries and keep them supplied with up-to-date information on all advances in practice and science Experiments have already been made in the distribution of original articles for reproduction in the technical press overseas

Dr Williamson has been adviser in agricultural chemistry to the University College of South Wales and Monmouthshire This post was a war-time creation, but he has built up a department which is now rendering valuable service to the farming community in South Wales and Monmouthshire Before the War he was, for eleven years, chief chemist to the Egyptian Ministry of Agriculture He was entrusted with the reorganization of the department and expanded it to more than three times the size of the original, housed in laboratories designed by himself and with greatly extended activities in the way of research, advisory work and routine analysis In 1937, in recognition of his services, he was created a commander of the Order of the Nile by the King of Egypt Dr Williamson has also served on the staff of the Edinburgh and East of Scotland College of Agriculture and the University of Aberdeen

Proposed North Polar Flights

SEVERAL flights over the north geographical pole have been made since Rear-Admiral R E Byrd, U.S.N., made the flight in 1926 using Spitsbergen as a base Most important was the Soviet expedition of 1937-38, but more flights are required, not probably for geographical discovery but for magnetic and meteorological research Flights over Arctic Canada have been made on several occasions It is now announced that a series of flights over both the geographical and magnetic poles are being made by an expedition from the Empire Air Navigation School of R A F Flying Training Command The aircraft used is the Lancaster *Aries* which was flown round the world last autumn by Wing-Commander D C McKinley Four new Rolls-Royce Merlin XXIV engines have been installed The base of the expedition is in Iceland, at least for the flights over the geographical pole A Canadian base will later be used for flights over the north magnetic pole in Boothia Peninsula The objects of the flights are stated to be: to examine the behaviour of compasses and automatic dead-reckoning gear, and to collect data on engine handling as well as magnetism and meteorology The plane carries food for four weeks, sledging gear and arctic kit The crew, all told,

numbers eight and includes a medical officer, Wing-Commander R. H. Winfield.

Future of Base Metals

LIEUT. COLONEL EDGAR PAM, president of the Institution of Mining and Metallurgy, delivered his presidential address at the annual general meeting of the Institution held on May 17. He pointed out that a not inconsiderable part of mankind as a whole depend for their living, or for their comfort and convenience, on base metals such as copper, zinc, lead and nickel, any important trend affecting their availability is therefore of great general interest. One effect of the War has been the concentration of a limited labour force on production at the expense of development work, the ore reserve of most important mines has been seriously depleted and, in spite of efforts intensified during the War, no ore bodies of real importance have been discovered for many years. Progress has been made in mining and metallurgical methods, but no epoch-making improvement stands to our credit since the development of flotation. With the relaxation of the demand for war uses, the supply in the near future should be ample, but within a few years a shortage seems indicated.

In order to help in the Colonies and even perhaps in Great Britain the opening up of new mines and industries, the Government should intensify activity along the following lines: (1) extend geological surveys, including the boring of promising regions; (2) support universities and technical schools by the equipment of laboratories, the provision of scholarships and, above all, by the assurance of such conditions of employment for staffs that the very highest grade engineers will be attracted to the posts; (3) improve transport facilities and help in building central power stations in selected areas; (4) improve the general education of the population, especially in the Colonies, with particular emphasis on health, safety and the dignity of labour; (5) give assistance in the development of promising new plant or processes which require finance beyond the power of industry to supply. The Institution has also a part to play. In the absence of a Chamber of Mines in London, it might consider setting up and fostering a permanent committee always available to help the Government or any other body at short notice by studying and reporting on technical, educational, health or welfare matters. Such a committee would also watch legislation and in some cases initiate discussion with the authorities in England or the Colonies.

Preventive Medicine in Mexico

DR. ANGEL DE LA GARZA BRITO, director of the Mexico School of Hygiene (*Bol. de la Oficina Sanitaria Panamericana*, 23, 607, 1944), maintains that medical education in Mexico, while good on the whole, has failed to keep up with the rapid progress in medicine and especially its social aspects. He declares that medicine is tending to become a business rather than a profession. The only guide for the average student is the material success of men in certain fields. Public health is a neglected branch, and the time devoted to it in medical schools ranges from 43 to 100 hours, which is decidedly insufficient. An attempt should be made to correlate the clinical, medical and surgical aspects of disease with the preventive social aspect. The students, for example, should visit the homes of

certain patients in company with a social worker to gain an insight into the influence of background upon disease.

Conference on Microfilm and other Documentary Reproduction

A CONFERENCE on microfilm and other means of documentary reproduction, organized by the Association of Special Libraries and Information Bureau (ASLIB Microfilm Service, Victoria and Albert Museum, London, S.W. 7), will be held at the Royal Society's Rooms, Burlington House, London, W. 1, on June 1 at 10.30 a.m. and 2 p.m., and June 2 at 10.30 a.m. On June 1 there will be papers and discussions on methods of documentary reproduction and its scope and use, and on apparatus and its use in library services and training. On June 2, a 'brain-trust' meeting will be held at which a scientific man, a humanist and a librarian will discuss with representatives of the legal profession, authors and publishers the existing copyright legislation in connexion with documentary reproduction. Tickets of admission can be obtained from the ASLIB Microfilm Service: single session, 7s 6d, whole conference, 15s for members, 11s and £1 for non-members.

The Night Sky in June

New moon occurs on June 10d 04h 26m UT and full moon on June 25d 15h 08m. The following conjunctions with the moon take place: June 6d 12h, Mars 4° N, June 6d 21h, Venus 3° N, June 11d 15h, Saturn 0° 6' S, June 16d 21h, Jupiter 4° S. In addition to these conjunctions with the moon, Mercury is in conjunction with Saturn on June 24d 11h, Mercury being 2° 2' N. On June 11d 18h 38m, Saturn is occulted by the moon, reappearance taking place at 19h 29 8m. No occultations of stars take place during the month. Mercury rises about 20 minutes before sunrise on June 1 and sets about an hour after sunset on June 30. The planet is in superior conjunction on June 16. Venus is a conspicuous object in the eastern sky in the morning hours, rising at 2h 22m on June 1 and 1h 30m on June 30. It attains its greatest western elongation on June 24. Jupiter sets about 1h at the beginning of the month and at 23h on June 30. Saturn is becoming difficult to observe and sets about an hour after the sun in the middle of June. There will be a partial eclipse of the moon on June 2, invisible at Greenwich, but visible in the antarctic regions, Australia and eastern Asia. Summer solstice is on June 21d 19h.

Announcements

PROF. W. J. HAMILTON, professor of anatomy at St. Bartholomew's Hospital Medical School, has been appointed regius professor of anatomy in the University of Glasgow.

PROF. C. H. LANDER, professor of mechanical engineering at the Imperial College of Science and Technology, London, and formerly director of fuel research, Department of Scientific and Industrial Research, has been awarded the Melchett Medal for 1945 of the Institute of Fuel in recognition of his work on fuel during the past thirty years.

ERRATUM.—The new head of the Science Department at the South-East Essex Technical College, Dagenham, is Dr. J. F. J. Dippy, not Dr. Dippy as printed in *Nature* of May 12, p. 571.

LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications

Inheritance of Morphological Characters in the Sperms of Cattle

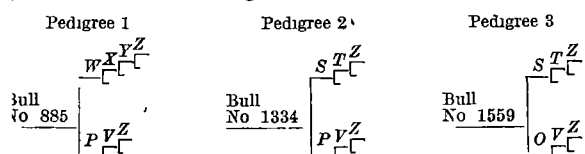
THE purpose of the present note is to record two findings which suggest the inheritance of certain morphological characters in bovine sperms as met in New Zealand

(1) There is a fairly constant difference in the shape of the Friesian or Shorthorn sperm-head when compared with the Jersey. After a lengthy experience, I am able to distinguish between the two kinds of sperm-smears with a large measure of accuracy. In a recent test, sixteen samples were submitted by a supervising meat inspector, who stated that the samples were "Friesian and Jersey". Differentiation was correct in each of the sixteen smears. Friesian and Shorthorn sperms usually have wider heads than Jersey sperms. Recognition of differences in other breeds, such as Ayrshires, Herefords and Polled Angus, has not been sufficiently constant, so far, to warrant the statement that these breeds may be picked from Jerseys to any significant degree, although Herefords and Ayrshires have been separated from Jerseys occasionally. It is thought that Herefords might usually be thus differentiated from Jerseys by the slightly wider sperm-head.

(2) The possible inheritance of other morphological characters within the Jersey breed may also justifiably be reported because of their importance from association with poor fertility. I am convinced that the presence and abundance of sperms with the abnormal character of re-turned tails and of sperms with narrow heads are largely determined by heredity, the two types of abnormalities being inherited separately. I am especially impressed by the fact that bulls, the ancestry of which led me to expect a certain sperm-picture, have shown the anticipated abnormality to a marked degree on examination. More particularly has this been the case in bulls which belong to the family known as the *Z* family and in the pedigrees of which bull *Z* figures on their sire's and dam's sides.

On occasion the sperm-picture has been foretold when the pedigree of a bull has been known, but the analysis of pedigrees so far performed does not entirely convince critical friends working in live-stock genetics. Many bulls prominent in pedigrees have long been dead and were never within range, and they stand far back in most pedigrees, though such bulls may appear several times in the same pedigree. These foundation bulls have many descendants, therefore any bull has a good chance of tracing back to one of these foundation sires and I hear more readily of bulls of poor fertility than of good ones. Caution must therefore be exercised in claiming inheritance, but further investigation is now my main concern.

To show the origin of the suggestion of inheritance of certain types of sperms, the three pedigrees which pointed the clue are given below



It was noticed that the sperm-pictures of these three bulls were similar and, on inquiry being made, it was found that they were closely related, the bull *Z* being a paternal and maternal ancestor, in direct male line, of the sire and dam of all three bulls. Bulls 885 and 1334 are half-brothers through their dam *P*, while bull 1334 is also half-brother to No. 1559 through their common sire *S*. The type of sperm notable in semen from these three related bulls is similar to that shown by Williams in "The Diseases of the Genital Organs of Domestic Animals" (1939 edition, p. 376, Fig. 125), this sample was collected by me, and the bull was in the same *Z* family as the three whose pedigrees are shown above. This type of abnormality is known here as 're-turned tails' because the tails are turned back past the head, but it is not suggested that this is the best possible terminology. Another family, prone to narrow heads as the particular sperm-type, is well depicted in the same work by Williams (pp. 380 and 381, figs. 128 and 129), both samples were collected by me and belong to the *D* family, the particular sperm-type of which, fortunately known to have been that of the foundation bull, *D*, himself, is narrow heads. It may be mentioned that the samples of which Williams gives photographs were collected in 1930 and 1933. Fig. 125 indicates a bad bull, Figs. 128 and 129 indicate total sterility. On the data analysed, it appears that bulls which have bull *Z* as paternal and maternal ancestor are eight times as likely to have a sperm-picture somewhat similar to Fig. 125 by Williams as are bulls not connected with *Z* for several generations back. Similarly, bulls which have bull *D* as paternal and maternal ancestor have five chances to one of showing many narrow heads when compared with the above-mentioned lot known as 'other bulls'. In the matter of fertility, of all bulls whose pedigrees are known, the *Z* family shows 29 per cent sterile and the *D* family 18 per cent sterile, as against the 'other bulls' group which shows 13 per cent sterile.

Certain important factors in this work, namely, the ages of the bulls generally, the ages of the sterile bulls, the methods of assessing fertility and the reasons for examination, as well as details concerning other related groups, are to be discussed in a later paper. It is agreed by the critical friends mentioned above that the slowness of breeding work with large domestic animals and the value of the economic stakes make it desirable to inform fellow-workers of strong suspicions when much time may be necessary for substantiation. The facts that different breeds of bulls can be recognized by their particular sperm-morphology and that the sperm-morphology of certain individuals of different families or strains in one breed can be anticipated seem to point to inheritance of those special types. During the past fifteen years it has not been possible for me to point to any other cause, which would bear criticism, for the lack of fertility shown by so many young bulls. The present contribution is the more permissible because of the rise of artificial insemination. By that means defective fertility might be spread widely. It is hoped that other workers may be stimulated to pay attention to the hereditary basis of abnormal sperm morphology or of some character of semen which can be correlated with impaired fertility.

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Calculation of the Results of Microbiological Assays

IN view of the increasing use of microbiological methods for the assay of vitamins, amino-acids, etc., I think it important to direct attention to the fact that the method at present employed of computing from the experimental data an estimate of the potency of the material assayed not only is theoretically unsound, but also may in practice give a result which is materially in error.

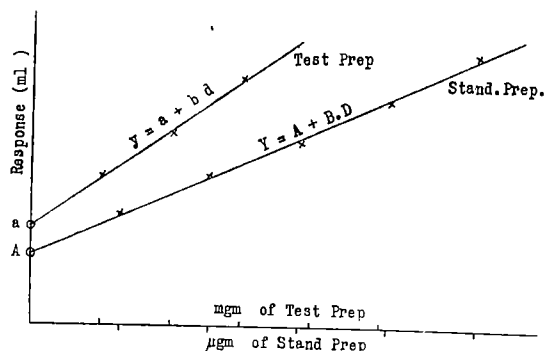
The procedure originally described by the pioneers in this field, and which has now become customary, is as follows. Tubes are put up containing several graduated doses of a dilution of the pure nutrient factor concerned (hereafter referred to as Stand Prep) and three or four different doses of the extract being assayed (Test Prep), besides the 'blank', in which no addition to the basal medium is made. After the usual incubation, and estimation of the growth in all tubes in terms of a titration, turbidimetric reading, or other measurement—for the sake of generality this will be referred to as the 'response'—a curve is plotted relating the dose D of Stand Prep to the response Y . From this curve the amount of the nutrient factor corresponding to the response y obtained from each dose d of Test Prep is read off. Three or four estimates of the potency of the Test Prep are thus obtained, and provided these do not differ among themselves by more than a certain amount (± 10 per cent is usually regarded as reasonable agreement) their average is taken as the final result.

It will be noted that the curve relating dosage of Test Prep to response is not plotted—or if it is, it does not affect the final calculation. I therefore refer to this as the 'single-curve' method of calculation.

The relation between D and Y is, over a certain range of dosage-levels, very closely linear in many microbiological assays, so that this equation is true

$$Y = A + BD \quad (1)$$

B is the 'slope' of the line and A is the value of Y when $D = 0$, that is, the intercept on the Y axis made by the line when produced backwards. In some cases A practically coincides with the 'blank', which is then a point on the Stand line, but in other assays the 'blank' is off the line.



Now if the response to the Test Prep is due to its content of the pure nutrient factor provided by the Stand. Prep., without augmentation, diminution or modification by anything else—and this hypothesis lies at the root of all assays—the curve relating dosage d to response y must be identical with the Stand

curve except that the scale is different, and the ratio of the scales is the only sound measure of the relative potencies of the two preparations. Thus if (1) is true of the Stand Prep, then the following form of equation must hold for the Test Prep

$$y = a + bd \quad (2)$$

and four important conclusions may be drawn.

(1) If the Stand points lie close to a line, so should the Test points also. Marked lack of linearity would render the assay suspect.

(2) The ratio of the potencies of the two preparations is given by b/B , the 'slope-ratio' of the two lines, and the potency of the Test Prep calculated from the slope-ratio will be a valid statement of the mean potency, over the range of linearity of the Stand Prep, irrespective of the shape of the curve outside these limits, provided that the hypothesis above referred to is true.

(3) Since the constants a , A , are independent of the kind or size of dosage given, they must in theory be equal. This means that if the Test and Stand lines are plotted on one graph—the scales chosen for each being immaterial, so long as they have the same origin—they should intersect on the axis of response, and any difference between them, if greater than is to be expected from the chance operation of experimental error, casts doubt on the validity of the assay; that is, it suggests that the basic hypothesis is not true. Whether the difference ($A - a$) found in any given assay is, or is not, big enough to cause suspicion can, and should, be tested statistically, but there is no space to go into this now.

(4) Mathematical investigation shows that unless ($A - a$) is approximately zero, so that the two lines intersect on, or very close to, the axis of response the 'single-curve' method of calculation may give results which, although they may agree with each other within 10 per cent, nevertheless differ from the 'slope-ratio' result by much more than this percentage. It is true that in such a case the whole assay is suspect and neither method may give a true result, but it is very likely (see below) that the 'slope-ratio' result is much nearer the truth than any other.

The following numerical example from one of several assays, the protocols of which were recently shown me, demonstrates that the matter is not merely of academic interest.

Dose	Riboflavin (μgm)					Test prep (mgm)		
	Blank	0.05	0.10	0.15	0.20	3	4½	6
Mean response (ml)	1.06	2.50	3.80	5.12	6.59	4.02	4.95	6.11

The Stand points will be found to lie very close to a line which includes the 'blank'. The three Test responses, read off from the line, lead to riboflavin contents of 35.7, 31.6 and 30.7 μgm per gm respectively—mean 32.7 μgm per gm. The three results are all well within 10 per cent of the mean.

The 'slope-ratio' method involves the plotting of the Test points as well. They also lie close to a line but—unlike the Stand line—it does not pass through the 'blank', ($A - a$) is, in fact, approximately 0.85 ml. The slopes of the two lines should be taken from the graph, but the following approximate computation gives in the present case an almost exact result. The increase in response from 0 to 0.20 μgm of riboflavin is $6.59 - 1.06 = 5.53$ ml, which is at

the rate of 27.65 ml per μgm . The increase in response from 3 to 6 mgm of Test Prep is similarly $11 - 4.02 = 2.09$ ml, or 696.7 ml per gm. The riboflavin content of the Test Prep is given by the ratio of these two slopes, namely, $696.7/27.65$ or $2.52 \mu\text{gm}$ per gm. Thus the result obtained by the 'single-curve' method, $32.7 \mu\text{gm}$ per gm, is nearly 10 per cent too high.

The explanation of the discrepancy is shown by further analysis of the data. The first and second additions of $2 \mu\text{gm}$ of riboflavin produced increases in response of $3.80 - 1.06 = 2.74$ and $6.59 - 3.80 = 2.79$ ml, respectively, that is, nearly equal increments at the first and second additions of 3 mgm of Test Prep will be seen to have given incremental responses of 2.96 and 2.09 ml, which are much too unequal for the difference to be due merely to random errors. It may be that the first 3 mgm of Test Prep provided the bacteria not only with riboflavin, but also with some other factor they needed which was *partially* deficient in the basal medium, while the second 3 mgm provided riboflavin only, the deficiency in the other factor being now fully made up. This possibility is strengthened by the fact that the response to the second 3 mgm can be subdivided by using the response to a dose of $4\frac{1}{2}$ mgm, and the two $1\frac{1}{2}$ mgm increments are then seen to have produced increases in response of 0.93 and 1.16 ml, respectively—that is, the difference is now within the limits of experimental error, so that the disturbing influence, whatever it may be, ceases to have effect after the first 3 mgm of Test Prep have been added. Mathematically, the assay as a whole is suspect; if there is anything in this argument at all, the incremental responses to the second 3 mgm of Test Prep should be a fairly good measure of its riboflavin content, even when the incremental response to the first 3 mgm is not. This is the reason why I state above that even in a theoretically invalid assay, the 'slope-ratio' result may be reasonably accurate.

If other workers will go back through their records, plot their Test Prep lines on the same graph as their standard Prep lines, and recalculate their results by the 'slope-ratio' method, I believe they will find many cases where $(a - A)$ is suspiciously large, and am sure that in such assays the 'slope-ratio' calculation will lead to a result markedly different from the true one. In any event, the use of the 'single-curve' method should be abandoned, as having no advantages and being inherently unsound, and the standard Prep line should always be plotted, if only to give an 'eyesight' test of the validity of the assay.

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Thiol - Vitamin K Mechanism in the Clotting of Fibrinogen

FROM an investigation into the chemical mechanisms involved in the conversion of fibrinogen into fibrin gel, it appears that the conversion occurs in at least two stages. The first stage is marked by the liberation of thiol groups in the fibrinogen molecule. The second stage is an oxidation of these thiol groups, which unite to form disulphide linkages with adjacent molecules. It has now been found possible to isolate three intermediate

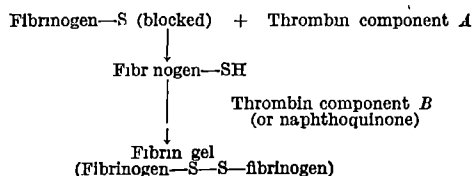
products which react when thrombin clots fibrinogen. Thrombin can be divided into two active components which have separate and distinct functions. Neither component will convert, *per se*, fibrinogen into fibrin, but the mixture of the two will readily clot fibrinogen.

Thrombin component A reacts with fibrinogen liberating thiol groups to form an intermediate, fibrinogen B, between fibrinogen and fibrin. This intermediate is formed during normal clotting in approximately a tenth of the time required to form a fibrin gel. The intermediate, when isolated, can be clotted by thrombin component B, or can be immediately converted into a fibrin gel by minute amounts of 2-methyl-1 4-naphthoquinone in 50 per cent alcohol solution.

Examination of the gels thus produced by either thrombin or 2-methyl-1 4-naphthoquinone using dark-ground illumination and a magnification of 900 diameters showed finely fibrillary gels, and no differentiation could be made between the two.

Evidence suggests that vitamin K is either a prosthetic part of thrombin component B, or that it converts a protein fraction into an oxidation-reduction system with a potential in the vicinity of that of vitamin K. Sensitive colour reactions^{1,2} suggest that a quinone structure is present in the thrombin molecule. Both reagents give a slight reaction when applied to the ether extract of thrombin which has been digested by trypsin.

The reaction between thrombin and fibrinogen can be illustrated by the following scheme:



Evidence in support of this scheme is both polarographic and chemical. (1) Polarographic analysis shows a relatively large number of thiol groups in fibrinogen B. (2) Similar analysis shows relatively few in native fibrinogen. (3) The isolation of thrombin component A, which will convert native fibrinogen into fibrinogen B, but will not clot it. (4) The isolation of thrombin component B, which has no reaction upon native fibrinogen, but which will convert fibrinogen B into a fibrin gel. (5) Addition of small amounts of thrombin to native fibrinogen temporarily increases the concentration of thiol groups. (6) Fibrinogen B will gel immediately upon the addition of $1 \mu\text{gm}$ of 2-methyl-1 4-naphthoquinone in 50 per cent alcohol per ml of fibrinogen solution, but not upon the addition of alcohol alone. Native fibrinogen is unaffected by an excess of 2-methyl-1 4-naphthoquinone. (7) When thrombin and fibrinogen have been reacting for at least a tenth of the normal clotting time, clotting is immediate if an excess of 2-methyl-1 4-naphthoquinone is added. (8) It is essential that the naphthoquinone be added after the thrombin, since the alcohol in which the naphthoquinone is dissolved inhibits the formation of fibrinogen B. (9) Thrombin digested with trypsin gives a colour-reaction characteristic for naphthoquinone with 2 4-dinitrophenylhydrazine. (10) The clotting of fibrinogen by thrombin is greatly accelerated by peroxidase (which could re-oxidize the naphthol form of naphthoquinone resulting from the oxidation of thiol groups). (11) Fibrinogen in both forms catalyses the iodine-sodium azide reaction, a function of $=\text{S}$

and —SH linkages, but fibrin does not (—S—S— linkage does not) (12) Fibrin is readily soluble in sodium sulphide, which disrupts —S—S— linkages (13) Blood clotting can be inhibited by an excess of thiol compounds and by substances which react with thiol groups (a) mercury compounds, (b) arsenic compounds of the arsenoxide type, (c) cyanides (14) The immediate oxidation of thiol compounds by 2-methyl-1,4-naphthoquinone can be shown polarographically

It is not suggested that the conversion of fibrinogen to fibrin occurs when one molecule of fibrinogen is united to another by a single —S—S— linkage, but that the fibrinogen molecule contains many potential —SH groups, and that these unite in a definite pattern forming long chains and ultimately give rise to the typical fibrin gels

Details of the experiments which gave rise to these findings will be published elsewhere

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Feb 13

¹ Craven, R., *J Chem Soc.*, 1605 (1931)

² Novelli, A., *Science*, 93, 358 (1941)

Methionine and the Fatty Liver of Infant Pellagrins

On a previous occasion, we were able to demonstrate that the intensely fatty liver is an invariable concomitant of pellagra in infants. This fatty liver responds poorly to a balanced diet with, or without, supplements of vitamin concentrates, chiefly of the B₃ complex, it recovers slowly when treated with crude liver extract but is rapidly and completely healed by ventriculin^{1,2}.

In order to obtain further information concerning the nature of this fatty liver, we decided to test the effects of methionine under controlled conditions. The amount of methionine available to us was just sufficient for two cases. One child was three years of age and the other fifteen months. As a control, we used another fifteen months old pellagra. The three cases were selected, not only on the basis of the clinical criteria on admission, but also on the similarity of the liver lesion as determined microscopically.

The three cases were submitted to biopsy within an hour of admission to hospital, and when it was established that the fragment of liver was intensely fatty, with almost every cell containing a single, large globule of fat, such as is described previously in our category 1², or type 1, *b* variety³, treatment was then instituted. The cases were put on the same basal diet of mealie meal (maize) porridge and half-strength milk and, in two cases, methionine was added in amounts stated below. Biopsy of the liver was performed in all cases soon after admission, a day after the last dose of methionine or, in the case of the control, at the end of one week.

Case 1 was a three-year-old infant. A total of 8 gm of methionine was administered orally over four days. The treatment was stopped because the clinical condition deteriorated and the oedema became intensified. The liver, at this stage, was even worse than on admission to hospital. Treatment with a full diet and ventriculin resulted in the disappearance

of the oedema fluid within four days, and the liver fat became absorbed, but at a much slower rate than in cases not pre-treated with methionine.

Case 2 was aged 15 months. A total of 11 g of methionine was administered orally over seven days. The clinical condition did not improve and the oedema became intensified. Another biopsy of the liver was performed and the fat was almost abundant as at the outset of the treatment. At the end of the first week, when the administration of methionine was stopped, the ventriculin treatment was instituted. This child also recovered slowly.

Case 3 was the control and also 15 months old. On admission, the liver was indistinguishable histologically, from those of Cases 1 and 2. The baby received no treatment other than half-strength milk and mealie meal porridge. Although the clinical condition did not improve, the liver, at the end of one week, did show some deterioration. After treatment for one week with ventriculin, the child made a rapid but uneventful recovery.

In all cases the livers were examined by fluorescence microscopy. Typical vitamin A fluorescence was not observed in the Kupffer cells. However, many of the big droplets of fat showed a dull greenish white fluorescence. Popper and Chinn⁴ maintain from their experiments in rats, that vitamin A fluorescence disappears from the liver in cholesterol deficiency, but in human infants we have found that the fluorescence of the fat droplets in the liver remains, even after treatment with methionine, and the Kupffer cells remain free from vitamin A fluorescent material.

From this investigation we conclude (a) In conjunction with a high carbohydrate diet, methionine in the amounts used over a short period, does not remove the fat from the livers of human pellagrins in a manner comparable with that described by ventriculin. (b) Fluorescence of the fat droplets in the livers of infants does not imply that they will respond to methionine. (c) Methionine, under present conditions stated above, neither removes the oedema fluid nor does it lead to clinical improvement. (d) High carbohydrate diet in infants has not the lipotropic action in children which it has in many adult pellagrins⁵. (e) Either methionine, in the amounts used over 4–7 days, is incapable of acting as a lipotropic substance in infant pellagrins, or it requires some additional dietary substance to exert its lipotropic effect. Channon *et al*⁶ suggested from experiments in rats. (f) Ventriculin, in conjunction with a full diet, is still the best treatment for pellagra in infants. The limited amount of methionine available to us (20 g) prevented us from carrying out more exhaustive experiments.

We are indebted to Mr Brown, of Glaxo Laboratories, Johannesburg, for the methionine.

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Feb 28

¹ Gillman, J., Gillman, T., Inglis, J., Friedlander, I., and Hamer, E., *Nature*, 154, 210 (1944).

² Gillman, T., and Gillman, J., *J Amer Med Assoc*, in the press.

³ Gillman, J., and Gillman, T., in the press.

⁴ Popper, H., and Chinn, H., *Proc Soc Exper Biol and Med*, 202 (1942).

⁵ Gillman, J., and Gillman, T., in the press.

⁶ Channon, H. J., Mainfold, M. C., and Platt, A. P., *Biochem J*, 866 (1940).

Concentration Regulation and Volume Control in *Lumbricus terrestris* L.

PREVIOUS work on these topics (Adolph and Adolph¹, Adolph², Maluf³, Wolf⁴, Maluf⁵, Wolf⁶) has assumed that the earthworm is a freshwater animal, and that volume changes are inversely proportional to changes in the concentration of the body fluids. Soil analyses (Russell⁷) show that the osmotic pressure of soil is higher than the above workers have assumed. Moreover, in the case of another annelid, *Nereis diversicolor*, Beadle⁸ has shown that the body volume can remain constant while the body fluid is diluted. Both assumptions may therefore prove unsound.

Earthworms were kept in filter paper moistened with saline solutions, and the concentration of the body fluid was determined. The body fluid used for each determination consisted of a mixture of the coelomic fluid and blood of four worms. This was analysed for chloride, and the conductivity of a warmed diluted sample was measured. Changes in weight were also followed, the worms being weighed in air after gentle rolling on filter paper. Equilibrium body fluid concentrations are given in the upper graph, and equilibrium changes in weight in the lower graph.

The upper graph shows that the animal possesses well-developed powers of concentration regulation, which are equally effective in media of widely different ionic compositions. It can maintain a hypertonic body fluid in 'dilute' media, and a hypotonic body

fluid in 'concentrated' media. Few animals so far investigated are able to maintain hypotonic body fluids, and in each case it has been supposed that they have evolved from fresh water (see Beadle⁹). It is possible to argue in a similar manner that *Lumbricus* has evolved from a freshwater to a semi-terrestrial habitat. The earthworm is certainly no longer a freshwater animal in so far as its osmotic relationships with the environment are concerned.

The lower graph shows that body weight (that is, body volume) depends on the nature and concentration of the medium. Comparison with the other graph shows that in many media, volumes and concentrations both increase. Volume control and concentration regulation are apparently not intimately correlated, at least under the present experimental conditions. Almost all the previous work is based upon an inverse relationship between concentrations and volumes, and therefore some revision of past conclusions may be necessary.

WILLIAM STEPHENSON.

Department of Zoology,

University of Bristol. March 12.

¹ *J. Exp. Zool.*, **43**, 105 (1925).

² *J. Exp. Zool.*, **47**, 31 (1927).

³ *Zool. Jahrb.*, **59**, 535 (1939).

⁴ *Anat. Rec.*, **75** (suppl.), 139 (1939).

⁵ *J. Cell. Comp. Physiol.*, **16**, 175 (1940).

⁶ *Physiol. Zool.*, **13**, 294 (1940).

⁷ "Soil Conditions and Plant Growth" (7th edit., 1937); see p. 582.

⁸ *J. Exp. Biol.*, **14**, 56 (1937).

⁹ *Biol. Rev.*, **18**, 172 (1943).

Pigmentation of Orthoptera

THE wings and skin of the green *Mantis religiosa* L. contain not a green but a yellow and a blue pigment. The yellow pigment is of a carotenoid character, soluble in alcohol, ether, chloroform, acetone, benzene, etc. It is insoluble in water. The parts treated with the ether leave their blue pigment in the water. This pigment is precipitated from the aqueous solution by ammonium sulphate to saturation. It is very probably a chromo-protein (*orthopteroerythrin*). It is immediately decomposed by a few drops of cold concentrated acetic acid.

The blue colouring matter (*orthopteroerythrin*) passes into chloroform, ethyl acetate or amyl alcohol. These solutions give the Gmelin reaction of biliary pigments (violet rings, then green) with strong nitric acid. The aqueous solutions show a strong biuret reaction.

The phytophagous Orthoptera, such as *Acrida tigris* L. and *Phaneroptera quadripunctata*, have the yellow and blue components, while in the hind wings of *Oedipoda caerulescens* and *Oed. schottii* there is only water-soluble pigment.

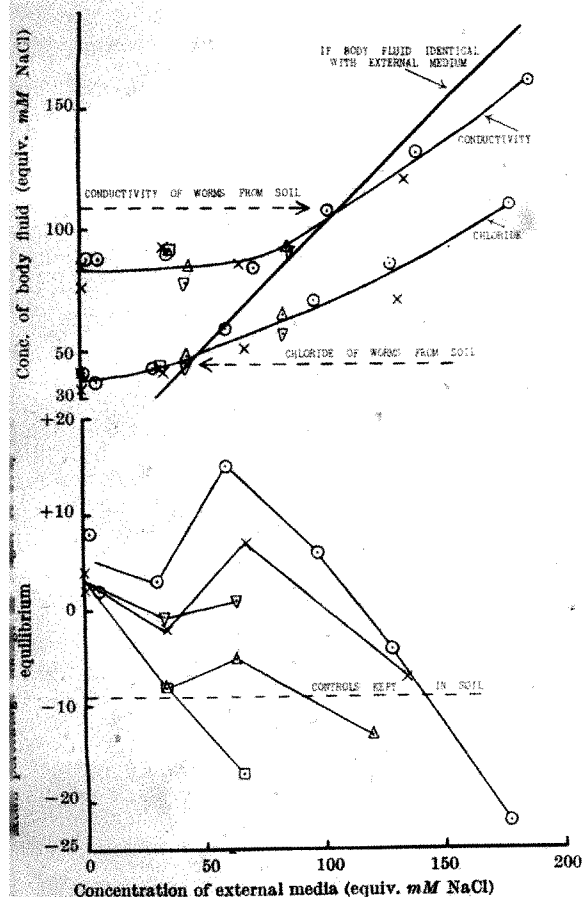
The green haemolymph also contains the blue and yellow components. A green drop, absorbed by filter paper, turns blue in an organic solvent. A blue drop is in turn dissolved in water.

The bright red hind wings of *Oedipoda miniata* Pall., as well as an orange-yellow carotenoid, contain also a red pigment soluble in water. It is probably a chromo-protein (*orthopteroerythrin*). It is decomposed by acetic acid, like the blue pigment. The red colouring matter (*orthopteroerythrin*) gives the Gmelin reaction, while the aqueous solution shows a strong biuret reaction.

SALAHETTIN OKAY.

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Easy Demonstration of Nuclear Division in an Animal Cell

THE chance appearance of a perfectly stained nematode egg in a smear of intestinal Protozoa prepared by a student (Marjorie Ind) led to the making of preparations *ad hoc*. The details of nuclear division in these were clear, and as cytology is strange ground to me I consulted Dr. C. D. Darlington.

The worm first treated was *Nematospiroides dubius* Bay. (Strongyloidea), kindly identified by Dr. H. A. Baylis. It is a very common parasite of the upper part of the small intestine of the woodmouse, *Apodemus sylvaticus*, pink in colour, coiled into a characteristic tight spiral column, the female worm being about 10 mm. in length. The eggs segment to eight cells *in utero*. A mouse may yield more than a hundred worms, and in the colony in my garden all seem to be infected. They are caught by a box trap with oatmeal on the floor and a raisin on the trigger.

Owing to the large size of the eggs of the worm the treatment is rather slow. Put one to four female worms on a coverslip with just enough saline to hold them; cut across repeatedly with needles to release eggs and pieces of oviduct containing eggs and sperm; smear with a stroke of the needle; float film downwards on to freshly mixed alcoholic Bouin's fluid; reverse after a minute and fix for three hours. The smear is allowed thirty minutes at each alcohol change and staining is by Delafield's haematoxylin, port wine colour, overnight. Differentiate with 1 per cent acid alcohol for three hours; blue the film in slightly ammoniated alcohol of the same grade; clear with clove oil for thirty minutes and allow a few minutes in xylol before mounting.

The common strongyloid worm, *Oswaldocruzia* sp., of the frog intestine answers equally well, and no doubt many other small nematode worms will do so. This opens up a field of investigation, as Dr. Darlington says that, in spite of the classical example of *Ascaris*, very little is known about the chromosomes of nematodes. The clearest picture is given of meiosis in the maturing eggs, a series of several often lying in a piece of oviduct and showing successive steps. There are six bivalents all showing terminal chiasmata, and at late metaphase these appear like a circle of large diplococci which can be counted with the 1/6 objective (see photomicrograph). Mitosis also can be followed in the segmenting egg, but is less clear in detail than meiosis as the chromosomes appear

as a ring, or double ring, of minute granules on quite clear spindle. Chromosome behaviour is much the same in both the species of worms examined. Dr. Darlington considers that a study of meiosis will prove more important than the mitosis which does not show the features (that is, diminution) of the *Ascaris* type.

Methods of preparing smears for chromosomes are of course, well known, but the application to nematode worms appears to be new, or not generally known. It is for its possibilities for class work that this casual discovery makes its appeal to me. The zoologist need no longer go to plants for the demonstration of nuclear division. The worms from wild mice, voles, frogs or toads are available at any time of the year. No skilled dissection is required and the technique is simple. The student who has helped me with the preparations was successful in her first attempts with little conning. It is hoped that some worker who has access to living hookworms, *Ancylostoma* and *Necator*, will make tests with these and report on the results. The eggs are very similar to those of the worms here dealt with and should be even more readily manipulated.

LL. LLOYD.

The University,
Leeds, 2. March 17.

Species of *Lucilia* Attacking Sheep in South Africa

Two species of *Lucilia* are stated to be associated in the sheep blowfly complex in South Africa. One of these, *Lucilia cuprina* Wied. is regarded as the main primary fly which produces strike in living sheep. *L. sericata* Mg., on the other hand, is not considered as important in this respect, although known to be the chief cause of strikes in Europe.

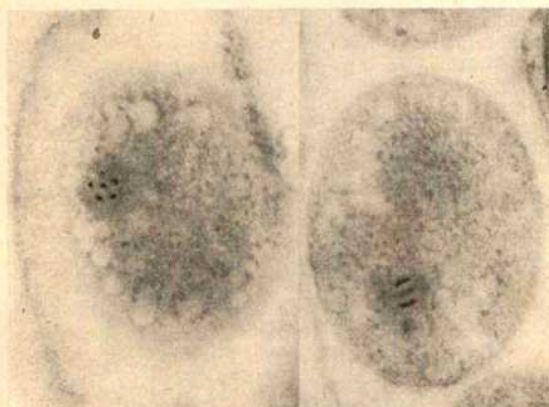
The systematic separation of the two species rests mainly upon a difference in the colour of the femur of the fore-leg in the adult fly. In *L. cuprina* this is bright green; in *L. sericata* it is black. In *L. cuprina* the abdomen is green with a bronze sheen; in typical *L. sericata* fly it is a distinct blue-green.

In any batch of field material containing both species, there is nearly always a gradation in the colour of both femur and abdomen so that, with certain individuals, a correct classification is difficult. The colour of a fly can also vary with the composition of the larval food supply. In addition, colour is often misleading, and in some cases is largely dependent upon the opinion of the observer. It is therefore not a scientific criterion.

The two species of flies are biologically identical. Both are attracted to, and breed upon, carrion, and both occur in wounds on the living sheep. Moreover, they interbreed readily in captivity and there is little doubt that they also do so in Nature.

In breeding experiments carried out at this Laboratory, crosses were made in both directions which gave rise to fertile progeny. In the F_1 generation, the green femur of *L. cuprina* and the blue-green abdomen of *L. sericata* proved to be dominant, all the progeny having these two characters. In the F_2 generation segregation occurred, giving individuals of three types, namely, (a) with green femur and bronze green abdomen (typical *L. cuprina*); (b) with green femur and blue-green abdomen (hybrids); (c) with black femur and blue-green abdomen (typical *L. sericata*).

In a typical batch of F_2 progeny from such



MATURING EGGS OF *Nematospiroides dubius* (NEMATODA) SHOWING THE NUCLEUS IN MEIOSIS: POLAR AND SIDE VIEWS. $\times 500$. PHOTO. BY J. MANBY.

cross we obtained 57 individuals of (a), 201 individuals of (b), and 62 individuals of (c). This gives an approximate ratio of 1:4:1. This ratio was reasonably constant with all batches examined. Colour, therefore, behaves as a Mendelian character with tetraploid characteristics.

In practice, this result means that colour cannot be used legitimately as a means of separating the two species and, if this is the only character available, they should be looked upon as, at the most, two forms of the same species.

Field material always contains individuals which conform in appearance to the hybrids of the F_2 generation mentioned above. Thus, if all flies exhibiting a green femur are to be put down as *L. cuprina*, we are including under this form a proportion of the population which, strictly speaking, cannot be singled out as either *L. cuprina* or *L. sericata* but which is, in reality, the hybrid form. Because of this, it is more than probable that records dealing with *L. cuprina* bred from living sheep include these hybrids. This would explain the very high proportion of *L. cuprina* said to occur on sheep as contrasted with the low numbers of *L. sericata*. In reality, it is more likely that the typical forms occur in approximately equal numbers.

If this is accepted, the conclusion that *L. cuprina* is the main primary fly is incorrect. Although Australian workers regard the crossing of the species in the field as an unlikely contingency, they advance no convincing reason for this opinion. As the hybrid form appears in field collections, we are more justified in concluding that it does take place on an appreciable scale.

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Pretoria Feb 5

Origin of a Toxicity to Mycorrhiza in Wareham Heath Soil

CONSIDERABLE interest has been aroused by the researches of Rayner¹ and Neilson Jones² on a growth failure of conifers at Wareham Heath, Dorset. These workers have demonstrated that this growth failure is associated with the development, in the soil, of a definite toxicity to the mycorrhizal fungi normally associated with these trees, and have presented convincing evidence that the toxicity is of biological origin. Neilson Jones has suggested that it may be due to production of hydrogen sulphide by aerobic sulphate-reducing bacteria. We have now been able to show that the toxicity may be due, at least in part, to the production of fungistatic organic substances by certain *Penicillium* spp. characteristic of the Wareham soil microflora.

Our observations on the mould flora of a sample of Wareham soil, as determined by plating on Jensen's agar, confirm those of Neilson Jones, such organisms as *Mucor* spp., *Trichoderma viride*, *Penicillium chrysogenum* and *Fusarium* spp. abundant in meadow or arable soils, are virtually absent. The mould flora is almost restricted to certain *Penicillium* spp., the most abundant of these being several strains of *P. janczewskii* Zai, a number of slightly differing isolates which are tentatively attributed to *P. janseni* Zai and a number of strains distinct from *P. janczewskii* Zai but clearly falling into the group described by Thom as the *P. nigricans-janczewskii* series.

Cultures of these moulds have been grown on a range of liquid media and these have been periodically assayed for antibacterial activity by serial dilution tests with *Staphylococcus aureus* and *Salmonella typhi*, and for fungistatic activity by a spore germination test with the conidia of *Botrytis allii*. Using this technique, we have found that the isolates provisionally identified as *P. janseni*, after seven days incubation at 25° C on a Raulin-Thom medium, produce a culture filtrate which will inhibit germination of *B. allii* conidia at a dilution of 1 in 64, and growth of *Staphylococcus* or *Salmonella* at similar dilutions. The isolates referred to the *P. nigricans-janczewskii* series, on the same media and under similar conditions, will produce culture filtrates inhibiting germination of *B. allii* conidia at a dilution of 1 in 32, but requires higher concentrations to inhibit growth of *Staphylococcus* or *Salmonella*. We have not been able to demonstrate the production of inhibiting substances, under these conditions, by the *P. janczewskii* isolates, but we have found that on media containing organic nitrogen, culture filtrates are produced having a peculiar distorting effect on germ-tubes of *B. allii*, even at dilutions of 1 in 500.

The active antibiotic substance produced by our strains of *P. janseni* has been isolated by extraction of the culture filtrate with chloroform, evaporation to dryness at reduced pressure and crystallization from ethyl alcohol. The substance thus obtained crystallizes from ethyl alcohol in small colourless prisms which appear throughout the liquid in clusters resembling pairs of wings. It decomposes without melting at about 205° C, and the decomposition products melt at about 225° C. The analysis of this substance (Table 1) agrees with that of gliotoxin^{3,4,5}.

TABLE 1

%	I Found	II	Calc for C ₁₅ H ₁₁ N ₇ S ₂ O ₄
C	48.1	47.9	47.8
H	4.5	4.5	4.3
S	19.4	19.7	19.7
N	8.4	8.9	8.6

However, authentic gliotoxin produced by *Trichoderma viride*⁶ crystallizes in separate prisms from ethyl alcohol, while large rosettes of prisms are formed on the walls of the container. Although there is a considerable difference in the appearance of the two specimens, a comparison of their properties has shown the two to be identical. The specific rotations agree within the limits of experimental error. For a solution of 0.4 gm gliotoxin from *P. janseni* in 100 ml chloroform $[\alpha]_D^{17.5}$ was -248°, and for a solution of 0.65 mgm gliotoxin from *T. viride* in 100 ml chloroform $[\alpha]_D^{19}$ was -243°.

The absorption spectra in the ultra-violet have been studied by Mr F. M. Page and Dr W. C. Price. Solutions of the two specimens give the same absorption curve.

Biological properties of gliotoxin from *P. janseni* and from *T. viride* are identical, so it is concluded that the observed differences in size and arrangement of the crystals were in all probability due to traces of impurity in one or other of the samples.

We have found gliotoxin to be highly toxic to mycorrhizal fungi. Various concentrations of gliotoxin were included in malt-extract agar (pH 5.2) by addition of Seitz-filtered aqueous solutions of gliotoxin to tubed agar medium at 40° C, followed

by rapid cooling to avoid decomposition of the gliotoxin. The degree of growth of a range of mycorrhizal and pseudomycorrhizal fungi on these media, after fourteen days incubation at 25° C, is recorded in Table 2.

TABLE 2

Gliotoxin μgm./ml.	<i>Boletus bovinus</i>	<i>Boletus elegans</i>	<i>Myc radicus nigro- strigosus</i>	<i>Myc radicus atrovirens</i>	<i>Rhizocto- nia</i> sp.	<i>Phoma radicus calluna</i>
0	++	++	++	++	++	++
5	—	—	+	+	+	++
10	—	—	—	—	—	++
20	—	—	—	—	—	+
40	—	—	—	—	—	—

++ normal growth, + reduced growth, — no growth

Newman and Norman⁶ have presented strong evidence that the low level of microbiological activity in sub-surface soils is due to the accumulation of antibiotic metabolic products of certain soil organisms. It appears plausible to suppose the toxicity of Wareham soil to mycorrhizal fungi, and its generally low microbiological activity to be due to accumulation of gliotoxin and other antibiotic substances produced by the *Penicillium* spp. dominating its mould flora. It is realized that further investigation will be necessary before final proof of this hypothesis can be offered.

We are much indebted to Dr M. C. Rayner for cultures of mycorrhizal and other fungi.

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H. G. HEMMING
J. C. MCGOWAN

Imperial Chemical Industries Ltd.,
Jealott's Hill Research Station,
Bracknell, Berks. March 1

¹ Rayner, M. C., *Forestry*, 8, 96 (1934), 10, 1 (1936), 13, 19 (1939), 15, 1 (1941).

² Neilson Jones, W., *J. Agric. Sci.*, 31, 379 (1941).

³ Dutcher, J. D., *J. Bact.*, 42, 816 (1941).

⁴ Johnson, J. R., Bruce, W. F., and Dutcher, J. D., *J. Amer. Chem. Soc.*, 65, 2005 (1943).

⁵ Brian, P. W., *Nature*, 154, 667 (1944).

⁶ Newman, A. S., and Norman, A. G., *Soil Sci.*, 55, 377 (1943).

Influence of pH and Salts on the Solubility of Calcium Oxalate

It has been observed that ingestion of soluble oxalates aggravates the condition of oxaluria. Barrett¹ has shown that oxalate absorption is reduced or even inhibited when milk or a soluble calcium

TABLE 1 M/5 PHOSPHORIC ACID, M/5 SODIUM HYDROXIDE

pH	1.56	1.65	1.76	2.00	2.26	2.45	2.74	3.20	5.37
ml KMnO ₄	30.00	27.05	24.55	17.80	15.60	13.40	10.90	8.00	3.70
pH	6.16	6.56	6.77	6.94	7.13	7.24	7.58	7.78	8.14
ml KMnO ₄	3.50	4.55	4.80	5.00	5.25	6.10	6.40	7.20	20.00
pH	8.42	8.80	9.06	9.42	9.70	9.90	10.20	10.40	
ml KMnO ₄	188	284	388	508	624	736	848	1084	

salt is taken simultaneously. He explains this as an immobilization of the oxalate as calcium oxalate, which is almost insoluble at the pH obtaining in the intestine. Whether intestinal absorption of calcium oxalate is influenced by other ions has been little investigated. Fiske and Logan² have noted the effect of magnesium, phosphate and sulphate on the solubility of calcium oxalate but have not presented quantitative data. We have investigated quantitatively the effects of acetate, borate and

pH	ml KMnO ₄
2.72	5.40
4.03	2.80
4.4+	2.60
5.27	2.90
7.26	2.90

TABLE 2 M/5 ACETIC ACID, M/5 SODIUM HYDROXIDE

pH	ml KMnO ₄
8.40	2.35
8.85	2.70
9.75	3.70
10.56	4.20

TABLE 3 M/5 BORIC ACID, M/5 SODIUM HYDROXIDE

phosphate ions at various pH values on the solubility of calcium oxalate.

The general principle adopted was the addition of various amounts of M/5 sodium hydroxide to a fixed amount of M/5 acid and dilution with water to a fixed volume. For example, to 50 ml M/5 phosphoric acid 5, 10, 15, etc., ml M/5 sodium hydroxide were added and the total volume made up to 200 ml in all cases. Excess powdered calcium oxalate was added and the mixture kept at 38° C. After determining the pH with a glass electrode potentiometer the mixtures were filtered and the filtrates titrated with potassium permanganate. The titration values given in the accompanying tables are in ml N/100 potassium permanganate per 100 ml filtrate.

From our results it appears that the solubility of calcium oxalate is little affected by acetate ions between pH values 2.72–7.26, and borate ions between pH values 8.40–10.56. In the presence of phosphate, however, the solubility decreases between pH 1.56 and pH 6.16, then increases gradually up to pH 8.2 and thereafter very steeply. Moreover the minimum solubility of calcium oxalate has a higher value in the presence of phosphate than of acetates.

In the pH range 6.5–8.0 reported to be found normally in the intestine, the solubility of calcium oxalate and therefore absorption of oxalate ions arising from calcium oxalate is small even in the presence of phosphates of the food. Should conditions arise leading to a greater alkalinity than pH 8.0, say, 8.0–8.4, in the intestine, we infer from our results that absorption of oxalates arising from calcium oxalate should be considerable in the presence of phosphates. That this increase in solubility is due to replacement of oxalate by phosphate is borne out by phosphate estimations on filtrates corresponding to pH 7.58 and pH 10.40 (Table 1). Although the initial concentration of phosphate in the two buffers was identical, the final values were in the ratio, phosphate (pH 7.58) : phosphate (pH 10.40) = 80 : 1.

A similar displacement was observed on the surface of a specimen of urinary oxalate stone when it was placed for a day in a Sorensen buffer of pH 8.0.

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¹ Barrett, I. F., *Lancet*, 213, 574 (1942).

² Fiske and Logan, *J. Biol. Chem.*, 93, 211 (1931).

Particle Shape

MR E J W WHITTAKER has directed attention¹ to the frequent use of the term 'needle-shaped' in chemical literature as a loose description of certain crystal shapes, and proposes a method of calculating an 'acicularity coefficient' to make this description more precise. Such a coefficient, however, would be characteristic not of the substance, but only of a particular batch of it formed under conditions which give rise to the particular 'habit'.

The bare description, 'needle-shaped', occurs frequently when a complete crystallographic description seems desirable. Its use is sometimes a confession of failure, the crystals being so thin that the observer cannot discover the exact nature of the terminations. Sometimes one feels that the term merely expresses lack of interest in the crystallographic details.

The measurements which Mr Whittaker suggests (three on each crystal) would involve a considerable amount of labour. If one's purpose is to describe a substance, it would seem better to expend the effort in an attempt to determine a few crystallographic constants which would be truly characteristic. If, on the other hand, one is interested in chemical reactivity or physical properties, a study of 'habit' may be valuable. In this case, however, the equidimensional particle (for example, cube or sphere) should be regarded as one end-point in the scale, as in Wadell's sphericity number. Wadell² expresses the sphericity by the fraction d_n/D_s , where d_n is the diameter of the sphere of the same volume as the particle and D_s is the diameter of the circumscribing sphere. A slight modification of his test may quite easily be applied to rectangular parallelepipeds, and if the sides are $a \geq b \geq c$ the degree to which the particle approaches the equidimensional habit (the cube) is clearly $\sqrt[3]{abc/a}$, the perfect cube being represented by unity. The cube possesses no relative elongation along its axes, and one mode of establishing a scale in which the cube has relative elongation of 0 is to define the elongation as $1 - \sqrt[3]{abc/a}$. Some may find it easier to comprehend these assessments if the values are all multiplied by 100, so that one can speak of a cube as being 100 per cent equidimensional, and an infinitely long needle as being 100 per cent acicular.

A more detailed classification of shapes by Zingg³ takes ratio into consideration in a somewhat similar manner to that used by Mr Whittaker, but Zingg's method leads to the recognition of tendencies towards our habits: spherical (for he approaches it from the sedimentary petrographer's point of view), disk-shaped, rod like and bladed.

It should be borne in mind that with microscopic articles, the measurement of two dimensions may be all that is practicable, and shape assessments based on this limited data may be better than no data at all.⁴

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Nature, 155, 331 (1945)

Wadell, H., *Pan-Amer Geol*, 61, 187 (1934)

Zingg, T., *Schweiz Min W Pet Mitt*, 15, 39 (1935).

Wadell, H., *J Geol*, 43, 250 (1935)

Rittenhouse, G., *J Sed Petrol*, 13, 79 (1943)

THE coefficients proposed by Mr E J W. Whittaker¹ for expressing shapes of rectangular parallelepipeds are not, in my opinion, quite satisfactory. The acicularity coefficient (ac/b^2) does not really express true acicularity, because the term 'acicular' means 'needle-shaped' and is commonly applied to elongated crystals with a cross-section approaching a regular polygon. The term 'acicular' cannot, strictly speaking, be applied to elongated tabular crystals, which are usually referred to as 'laths', if short, and 'blades', if long. Again, the isoproportionality coefficient ($a \cdot b$ or $b \cdot c$) does not express any significant shape, because it is based on two dimensions only.

Various coefficients can be devised for expressing the habit of crystals, but I think that the following coefficients are better suited to express the characteristic shape of a rectangular parallelepipedon ($a \geq b \geq c$)

$$1 \text{ Elongation } E = \frac{a^2 - b^2}{bc}$$

$$2. \text{ Tabularity } T = \frac{ab^2 - ac^2}{bc^2}$$

For a cube, both these coefficients are equal to zero

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¹ Nature, 155, 331 (1945)

MR S I TOMKEIEFF's criticisms of the coefficients I have proposed for expressing particle shape are based on two points: the term 'acicularity' applied to the coefficient ac/b^2 , and the use of $a \cdot b$ or $b \cdot c$ as the second shape parameter. With regard to the definition of acicularity, I would point out that my use of this term is an extension of its common meaning, so that it may be applied in a generalized sense to figures with three unequal principal dimensions. This extension is quite analogous to the extension of the terms positive and negative as applied to the indicatrix of biaxial crystals in crystal optics, these terms being derived from their use in describing the indicatrix of uniaxial crystals. Also, although my isoproportionality coefficient is not an explicit function of all three dimensions, it is not independent of any of their values owing to its definition as $a \cdot b$, or $b \cdot c$, whichever is the smaller, and it does, in combination with the acicularity coefficient, uniquely express any shape. Although there is a loss in mathematical rigour here, there is a great gain in simplicity.

Satisfactory coefficients for describing particle shape must satisfy the two mathematical criteria

(1) The coefficients must be homogeneous functions of a , b and c . (2) They must be independent.

They should also satisfy, so far as possible, the following four conditions: (3) The coefficients applicable to a complex shape should analyse that shape into two variables which are readily separated subjectively in the impression given by the complex shape. (4) Their numerical values should vary along a series of shapes in accordance with subjective estimates of the changes occurring from one shape to another. (5) The coefficients should be as easily calculable as possible from the values of a , b and c . (This is of considerable practical importance if a large number of particles is being measured.)

(6) The coefficients should possess whatever other properties may be required for the work in connexion with which they are to be used.

Elongation and tabularity probably satisfy condition (3) better than do the acicularity and isoproportionality coefficients. But subjective impressions are much less sensitive to slight changes of shape than are the numerical values of E and T , and the calculation of these coefficients involves a considerably greater number of operations than is required for the acicularity and isoproportionality coefficients. With regard to condition (6), the two systems are probably suited to different purposes. Thus on my system a mixture of tabular square prisms and elongated ones would always give mean coefficients corresponding to a square prism (or to a cube if the values were appropriately distributed), whereas on Mr Tomkieleff's system it would not.

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Chemistry at the Older Universities

In an article in *Nature* of February 10 on "Chemistry at the Older Universities of Britain during the Eighteenth Century", Dr Archibald Clow repeats a number of assertions of a highly flattering character, which have been made from time to time regarding John Mayow, by Beddoes, Yeats, Gotch, Gunther and others, statements which it is surely time to eliminate from the history of science. Dr. Clow says that Mayow's "De Sal-nitro et Spiritu nitro-aereo heralded the later discovery of oxygen", and he quotes, apparently with approval, Gunther's view that Mayow was the "greatest chemist whom Oxford ever produced". Also he says that "Mayow was not an associate of Boyle, indeed they seem to have been mutually unaware of each other's work, and Mayow's contributions remained hidden for many years".

In an article published some time ago entitled "John Mayow in Contemporary Setting"¹, I pointed out that these views—as, well as many others held regarding Mayow—are very erroneous, and that Mayow's work, far from being independent of Boyle's, was merely a pale reflexion from it. Mayow, in fact, mentions Boyle fairly often, and states that some of his experiments were similar to those of Boyle. Part of his endeavour was to show that what we call nitric oxide obeyed Boyle's Law, and although here he does not mention Boyle he very probably thought the connexion to be so obvious as not to require it. That Mayow's work was not hidden at all is shown by the fact that it received extensive review in the *Phil Trans* at the time of its publication.

On the other hand, that Boyle was aware of Mayow seems to be clearly indicated by the fact that Oldenburg, in a letter dated July 10, 1674, writing to Boyle, says "I hear some very learned and knowing men speak very slightly of the *quinque Tractatus* of J M, and a particular friend of yours and mine told me yesterday, that as far as he had read him, he would shew to any impartial and considering man more errors than one in every page"². All who have really studied Mayow's work are pretty certain to agree with these "learned and knowing

men". It is time that our perspective regarding Mayow was finally and definitely readjusted.

T S PATTERSON

University of Glasgow

¹ *Iris*, 15, 47, 504 (1931)

² Boyle's "Works", 5, 395b (1744)

It has been very kindly pointed out to me by Dr K. R. Webb, of Southampton, that I have done less than justice to Cambridge chemistry by omitting to mention that it was I Milner (1750–1820) who, although Jacksonian professor of natural philosophy and not a chemist *per se*, observed in 1788 the ammonia passed over heated manganese dioxide converted into red fumes which dissolve in water to form nitric acid. This oxidation of ammonia effected catalytically by atmospheric oxygen is the basis of the modern commercial method of preparing nitric acid. Both Milner and his successor, F J E Wollaston (1762–1823), taught chemistry and published plans of their courses.

Other minor points are 'Robinson', p 161, col 1, line 38, should read 'Robison', 'Vagani' should read 'Vigani' throughout, the intrusive comma between Cullen and went, p 160, col 2, line 41, should be deleted, the first of R Watson's Essays appeared three years earlier than stated, finally, although R T Gunther in "Early Science in Cambridge" (p 225) gives the date 1741, apparently Mickleburg (or Mickleborough) held office until 1756.

On the other hand, as far as Oxford is concerned following the long line of historians from Beddoes to Gunther I credited John Mayow with being one of the great luminaries of early Oxford chemistry. That this is not so has been discussed by Prof T S Patterson, and all chemists interested in the early history of their subject should refer to his masterly analysis referred to above.

ARCHIBALD CLOW

Department of Chemistry,
Marischal College,
Aberdeen

Exygnopia

From time to time I have experienced, immediately upon awakening from sleep (ἐξυπνοϛ), the ability to see with illumination below the threshold for scotopic vision. This power of seeing in the dark, which is transient, is quite different from scotopic (twilight) vision: the colour red can be distinguished, and the field of vision is small. I think that the portion of the retina employed is the *macula lutea*, a part which is generally regarded as being night-blind. That the illumination was really below the threshold for scotopic vision is confirmed by my wife who, on at least two of the several occasions, observed that the room (which was 'blacked-out') was pitch-dark.

The phenomenon appears to me to be an interesting survival of a faculty which must formerly have been of considerable value to man, a faculty analogous to that of pricking up the ears, which some of us doubtless the less highly civilized—still retain.

A F DUFTON

The King's Lodge,
Hunton Bridge
Hertfordshire
March 31

RESEARCH ITEMS

Some Interesting New Fishes

GEORGE SPRAGUE MYERS describes two remarkable mute blind fishes and some related forms in his recent work ("Two Extraordinary New Blind Hematognath Fishes from the Rio Negro, representing New Sub-family of Pygididae, with a Re-arrangement of the Genera of the Family, and Illustration of some Previously described Genera and Species from Venezuela and Brazil" *Calif Acad Sci Fourth Series* 23, No 40, Nov 1944). These two blind fishes, *Pygidianops egermanni* (new genus and species) and *Typhobelus ternetzi* (new genus and species), have no cheek spines. *Pygidianops* has no eyes, and *Typhobelus* they are rudimentary. They resemble each other closely but differ sufficiently to warrant a separate genera. They form a series with *Anapteryx anguilla* Myers, described previously in the same locality, rock pools below Sao Gabriel Rapids, Rio Negro Brazil, which possesses eyes and many ways resembles the other two. It is probable that the two blind fishes live buried in the sand. The author is of the opinion that the absence of cheek spines is a primitive feature which relates them to *Nematogenys*, the most primitive pygidid, and that they are probably derived from the Nematomyxinae.

New Genera and Species of New Zealand Collembola

A PAPER by J. T. Salmon of the Dominion Museum, Wellington (*Rec Dom Mus*, 1, 123, 1942-44), describes nine new genera and forty-one new species of *Collembola*. Nine varieties are classed, provisionally, as new sub-species, but the author is of the opinion that these are more probably only colour variations of the species. The paper is the result of an investigation (mainly in the Wellington area) of what is termed "the micro-Collembolan fauna of leaf-mould and soil". Full and systematic descriptions of the genera and species, together with twelve plates (one coloured) containing clearly executed illustrations, make this a valuable reference work.

New African Onychophora

R. A. HOLLIDAY records some interesting observations on the behaviour of peripatids in captivity. Further Notes on Natal Onychophora", *Ann Natal Mus*, 10, Part 3, Dec 28, 1944). These chiefly refer to *Peripatus mosleyi*. Apparently the young are born only towards the end of March and throughout April. The number of young produced by one female is 6-8 in a year, one, or more often two, at a time. The newly born young eats its first moult and then proceeds to fend for itself, the feeding habits being similar to the adult. The insect food is covered with a copious flow of saliva, and it seems that it is probably at least partially liquefied before being ingested. These notes are accompanied by a very beautiful series of photographs.

Schizotrypanum Cruzi

H. Meyer and M. X. Oliveira have published a paper with the title, "Sobre o Desenvolvimento Intracelular do 'Schizotrypanum Cruzi' Em Cultura Tecido Como Meio De Verificacao Da Autonomia Celular" (*Rev Brasil Biol*, 4, No 1), in which it is shown that there is a strict relationship between the life of *Schizotrypanum Cruzi* and the host cell. *Cruzi* continues to develop in the cells until it has exhausted all its nutrient media, and the physio-

logical condition of the cell determines the number of trypanosomes that are formed. From this it may be conjectured that cells in tissue cultures are independent units, because, on the assumption that an inter-cellular connexion exists, it would be possible for the parasite to migrate to an adjacent cell from which it could derive nourishment. A number of experiments proved, however, that this did not occur. Adjacent cells have the parasite in different stages of development, and so far the investigations have proved that the life-cycle of *S. Cruzi* is always restricted to one cell. The subject is to be dealt with more fully later.

Preferential Segregation in Maize

A. E. LONGLEY (*Genetics*, 30, 100, 1945) shows that in the presence of the knobbed chromosome 10 of maize the genes on other chromosomes which bear knobs sometimes show preferential segregation. Rhoades had already found that genes on knobbed-chromosome 10 segregated in a preferential manner. Longley shows that there is a preferential accumulation of non-homologous knobbed chromosomes in the functional megaspores. There results a preferential disjunction and accumulation of knobbed chromosomes to the functional megaspore. Two genetical results are to be expected and are shown to be occurring: (a) abnormal segregation of genes located near the knobs, (b) false linkage between genes on non-homologous chromosomes. There is little or no evidence of a corresponding behaviour in microsporogenesis.

Low-Temperature Requirements of Fruit Trees

DECIDUOUS fruit trees often fail to show normal spring bud-opening unless during the dormant season they have been exposed to low temperatures for periods which vary with the species and even with the variety. With grapes, C. A. Magoon and I. W. Dix (*Proc Amer Soc Hort Sci*, 42, 407, 1942) find that when the plants are placed in a greenhouse at 60-70° F. after exposure to 45° F., the number of days required for bud-break to occur is inversely related to the number of hours of exposure to the low temperatures. Here as with blueberries (G. M. Darrow, *ibid*, 41, 189, 1942) varietal differences exist and with blueberries the absence of sufficient winter chilling results in unsatisfactory spring growth and, frequently, the subsequent death of the plants. Delayed spring bud-opening, too, is exhibited by insufficiently chilled pecan trees, but C. W. V. Horn (*ibid*, 41, 65, 1942) reports that winter spraying with 2,4-dinitro-6-cyclohexylphenol prevents this delay in spring growth. On one variety (Halbert) that requires only very slight winter chilling, the effect of the winter spraying was only slight.

Energy Relation in Enzyme Reactions

ALTHOUGH on a thermodynamic basis a very large number of reactions may be theoretically possible in a given biological system, the presence of enzymes will result in the selective catalysis of only a limited number of these reactions. In the cell, the prominent processes of hydrolysis and condensation and of oxidation-reduction are accompanied by a variety of other reactions such as amination, deamination, alkylation and so on. Many such reactions are proceeding in the cell continuously and simultaneously. Proteins are constantly being broken down into their constituents and these degradations are balanced by syntheses. The position of this dynamic equilibrium

is determined not only by the thermodynamic potentials but also by the kinetics of the reactions catalysed by the individual enzymes. In "Energy Relationships in Enzyme Reactions" (*Ann New York Acad Sci*, 45, 357, 1944), by J S Fruton, E G Ball, M Bergmann, H M Kalekar, O Meyerhof and C V Smythe, some of these problems, such as the energy-yielding mechanisms favouring peptide bond formation, are discussed.

Aluminium Phosphide

FIVE different compounds of aluminium and phosphorus have been reported at different times, prepared in various ways. W E White and A. H. Bushey (*J Amer Chem Soc*, 66, 1666, 1944) prepared a phosphide by a method depending on passing hydrogen containing phosphorus vapour over an intimate mixture of finely divided aluminium and red phosphorus, and then starting the reaction by heating the mixture. A short, vigorous reaction occurred, and the product was cooled in hydrogen. The product was analysed in different ways and its composition found to be variable. The authors discovered, however, that the X-ray spectra were identical for the principal constituent, and by a visual comparison of the intensities of the aluminium lines on the powder diffraction patterns and a process of correlation with mixtures of aluminium powder and quartz, and by a consideration of the hydrogen liberated by acid, the conclusion was reached that only one compound, AlP, exists. The highest purity reached was 94 per cent AlP. The compound is remarkably stable to heat, but is, of course, decomposed by moisture with evolution of phosphine.

Average Magnetomotive Force Expended on Tapered Teeth

A PAPER by O I Butler (*J Inst Elec Eng.*, 92, Pt 2, No 25, Feb 1945) outlines the theory, method of construction and use of a family of curves allowing a rapid and accurate estimation of the average m m f expended on tapered magnetic teeth of an electrical machine. The parameters used result in less complicated relationships between the variables than with any alternative accurate method, this somewhat simplifies the calculations necessary to obtain the curves for magnetic materials having different B/H characteristics. An analysis is made of the inaccuracy of the simple 'one-third' rule under varying conditions of magnetic loading and tooth profile, and it is shown that the use of this rule can lead to very considerable errors.

Relation of Geomagnetism to Solar Activity

A J OL (*Bull Acad Sci URSS, Sér Géog Géophys*, No 6, 359, 1943) presents a new theory of geomagnetic phenomena in their relation to solar activity. This theory, originally suggested by M N Gnevyshev in 1938, attempts to correlate geomagnetic disturbances not with the individual solar phenomena but with the whole process of solar activity manifest in sunspots, solar flares and flocculi as developed in the active regions of the sun. Such a process is called the 'solar impulse'. The statistical study carried out by the author shows how much this theory can be developed and elaborated. It is shown, for example, that geomagnetic phenomena are associated with the phase of the solar impulse which follows its maximum phase. It is suggested that this theory provides a more precise correlation between solar activity and geomagnetism.

Atmospheres of Planetary Satellites

THE 82-in reflector of the McDonald Observatory has recently been used in conjunction with low- and medium-dispersion spectrographs to study the atmospheres of Pluto and of the largest ten satellites of the solar system. In his preliminary report on the results (*Astrophys J*, 100, 378, 1944), G P Kuiper reproduces a series of interesting spectrograms of the satellites and their primaries in the photographic visual and infra-red regions of the spectrum. On Titan, sixth and largest satellite of Saturn, is found to have an atmosphere of sufficient prominence to be detected, though Triton, Neptune's satellite, and Pluto are to be studied further. The composition of Titan's atmosphere is similar to that of Saturn though the optical thickness is somewhat less. The methane absorption bands at 6190 Å and 7260 Å show up well; and the ammonia band at 6400 Å, suspected on microphotometer tracings, though confirmatory plates will be needed to establish its presence. The presence of molecules rich in hydrogen on a body so small as Titan is rather surprising. Stability during astronomical periods is not possible for hydrogen itself under present conditions on Titan though methane and ammonia are retained. But a substantial increase in temperature, say, by 100° would result in rapid dissipation even of the present constituents. Consequently, the present atmosphere must have been acquired since Titan had the high surface temperature which current theory demands for all bodies of the solar system. Similar, though less compelling, considerations follow for Mars, Venus and the earth, in all of which the atmosphere must have escaped from the crust after the latter had cooled.

Variability of γ Cassiopeiae

D L EDWARDS, Norman Lockyer Observatory, Exmouth, in a paper 'Changes in γ Cassiopeiae During the Past Hundred Years' (*Mon Not Roy Astro Soc*, 104, 283, 1945) discusses all available observations of this star since 1830 with the object of detecting any variations of magnitude or spectrum before the previous outburst. The first suggestion of variability in γ Cassiopeiae was made by W. R. Birt (*Mon Not Roy Astro Soc*, 2, 79), and although he referred again to his suspicions twenty-six years later, does not appear to have followed the matter up. As a result of his collection of data, Edwards concludes that even before the recent outburst this star was subject to frequent variations in spectrum and magnitude, although these changes were small in comparison with those observed after 1933. In spite of the fact that the changes were frequently very small, they have been supported by independent evidence, often from different observers, and in several cases they are sufficiently large to leave little doubt as to their reality without any other evidence. The suspected changes occur at dates which fall into regular periodic series, and the best fit was found by trial and error, to be given by a double maximum with a separation of 4.30 years, recurring at intervals of 10.67 years. Hence the maximum occurred regularly at intervals of 4.30 and 6.37 years alternately, and these figures were used, with the well-determined date of 1937.3 as starting point, to determine computed dates of maxima. The observations fit very closely into the scheme with the exception of the 1934.6 outburst, and it is suggested that this was due to some exceptional cause.

NATURAL HISTORY OF SCRUB TYPHUS*

THE work of the last ten years on diseases of the typhus group has permitted us to understand certain sides of them much more clearly. It is now known that there is one disease of this group widely read in eastern Asia, transmitted from rodents to man by what we should call harvest mites. It should be known as 'scrub typhus' or alternatively as 'mite-borne typhus'. No good general account of it, particularly from the entomological side, is available in print. The disease is of considerable importance in the British Empire.

The natural history of the disease is complex, and may be best to approach it by setting down what is known about the so-called 'harvesters' of Britain and northern Europe. They are the larvae of *Trombicula autumnalis*, the so-called 'chiggers' of North America, are closely related. These larvae, which are fraction of a millimetre long, attach themselves to the skin of rodents, man, birds, etc., and hold on for several days. They drop into the soil, moult to become a nymph, moult again to become an adult and the female then lays eggs. Our knowledge of the life-history in the soil is fragmentary, but it seems to be established that the nymph and adult are vegetarians or that they feed on decomposing organic material. It seems that there is only one species in Britain, and it is probable that there is only one generation in the year. It is known that the rabbit and the bank vole are important hosts of the larvae. The bank vole, larvae are common in late summer and autumn and after that diminish through the winter, to fall to a minimum in June. The species occurring in Britain seems to be localized to light soils, particularly those which are chalky, and the distribution is often extremely patchy. It seems probable that, by applying methods worked out for problems of soil entomology, much might be learned about the biology of this animal.

In attaching itself to the mammal, the larval *ombicula* ejects a digestive juice which causes an area of hyaline degeneration. This often takes the form of a sharply defined column, vertical to the skin. Nothing is felt at the time when the larva is puncturing the skin, but some hours later irritation develops in some, but not all, human beings. The irritation may be quite serious, particularly to troops living in the field.

In south-east Asia there are many genera and species of Trombiculid mites, and the larvae of a considerable number of them attack man. Rodents are mainly important hosts, and the natural history of scrub typhus is very complex because of the variety of rodents in this part of the world.

The larvae are important because they transmit an infectious agent producing the disease, we call scrub typhus. The earlier work was mostly Japanese. It showed that the larva of *Trombicula akamushi* feeds normally on voles (*Microtus*) on alluvial soils, transmits infection from vole to vole or vole to man. As the mite only feeds on a mammal once in its life-history, the infection must be hereditary, and the virus has actually been recovered from wild adult voles. A similar or identical infection, always transmitted by larvae of *Trombicula*, is known or believed to occur in the great triangle bounded by Japan, New

Guinea and northern Queensland, Ceylon and the Maldives. Within this great area the disease may occur under exceedingly different environmental conditions, for example, in equatorial forest, or in grassland, or on barren islets and atolls.

In man the disease is generally serious. There is a small ulcer at the site of attachment of the larval mite, high fever and a considerable mortality. The disease is widely distributed over the area of south-east Asia, and as men are living and fighting in jungle, it has proved much more common than generally expected. It tends to be highly localized and to produce occasional outbreaks with a very variable but serious death-rate.

CONFERENCE ON X-RAY ANALYSIS*

THE second Annual Conference of the X-Ray Analysis Group of the Institute of Physics, and the fourth Conference on X-Rays in Industry which the Institute has arranged, was held in London at the Royal Institution during April 12-13. The Conference was an open one, and the attendance was about two hundred and fifty. The chairman, Sir Lawrence Bragg, opened by thanking the Royal Institution for the use of its premises, and welcomed scientific visitors from the Continent, who for the first time were able to be present at the Conference. Speaking of the X-Ray Analysis Group, Sir Lawrence reported briefly on its work during the past year. It now has 187 members, and in addition to its annual conference it held a meeting in Leeds last November on the performance of X-ray tubes. The committee has also produced recommendations for the design and dimensions of a standard powder camera, and has in hand the revision and reproduction of Beevers-Lipson strips for Fourier analysis. It was hoped that the Group might sponsor the publication of a journal for papers on the atomic structure of matter and allied subjects. The chairman, secretary-treasurer, and ten members of committee of the Group were declared elected, in the absence of further nominations. A warm vote of thanks was made to Dr Lipson for his work for the Group since its formation, his place as honorary secretary-treasurer is to be taken by Mr F A Bannister (Minerals Department, Natural History Museum, Cromwell Road, London, S W 7).

Absolute Values of X-Ray Wave-Lengths

At the Conference in 1943, the question of correcting X-ray wave-lengths, which were known to be in error by about 0.2 per cent, was left until the conversion factor might be more accurately known and international agreement might be reached as to its value. As these conditions are now at least partially fulfilled, the meeting considered further steps to be taken. Dr Lipson said that there are three possibilities to recommend immediately a value of the conversion factor, to leave the determination of the conversion factor to Prof M Siegbahn and the Americans who have worked on it, or to continue to use the old wave-lengths and await further developments. Of these he prefers the first.

* Substance of a Friday discourse at the Royal Institution delivered by Prof F A Buxton, F.R.S., on April 27.

* Report prepared by Audrey M B Parker, A R Stokes and A J C Wilson.

Dr W A Wooster said that it would be undiplomatic to do anything further until other men of science on the Continent can be consulted, but Dr W H Taylor considers that Prof Siegbahn is the only authority who need be approached. Dr Lipson said that the agreement between Prof Siegbahn's value of 1.00201 and the Americans' value of 1.00203 for the conversion factor is extremely good, and pointed out that an accuracy better than 1 part in 10^6 could scarcely be expected in view of the breadths of X-ray emission spectra. It was agreed after some discussion that the chairman should ask Prof Siegbahn and Dr R T Birge and Prof B E Warren to reach agreement on the best value of the conversion factor, after which the American and British X-Ray Analysis Groups should prepare new sets of tables of wave-lengths and crystal lattice parameters embodying the corrected values. For the time being it was agreed to use 'kX' instead of the (incorrect) 'A' as the abbreviation for 1,000 X-units.

Proposed Publication of a Journal

Sir Lawrence Bragg reported to the Conference on the discussions of a sub-committee on publication. There is at present no journal dealing satisfactorily with the interests of the Group, and papers on crystallographic subjects appear in nearly sixty different periodicals. The committee is satisfied that there are enough British papers yearly to make possible the publication of a quarterly journal. The scope of the journal would be determined by the material investigated, not the methods used, that is, it would cover structure of matter, not diffraction. The American Society for X-Ray and Electron Diffraction is discussing a similar project, and it might be possible to co-operate with them. The possibility of co-operating with Continental workers is also under consideration.

The Conference expressed its general approval of a new journal, and authorized the committee of the Group to continue with the project.

X-Ray Diffraction Technique

Two sessions for the presentation of scientific papers were held on each day. During the first morning session, a number of new and improved methods of use of X-ray diffraction were described. These were concerned more with techniques than with fundamentals, and embodied a large number of useful ideas for experimental work. Dr A Guinier described the use of convergent and practically monochromatic beams of X-rays obtained by reflexion from bent quartz crystals ground to a suitable curvature, and showed how very clear diffraction photographs can be obtained with short exposures. Mrs Nora Wooster spoke about the use of the Weissenberg goniometer for determination of the orientation of diamonds and the examination of the variation of perfection of crystal surfaces. There followed papers by Dr I MacArthur on the measurement of long spacings in protein fibres, including special precautions needed when spacings are of the order of 500 Å, by Mr J B Nelson on extrapolation methods for the elimination of errors in lattice parameter measurements, by Miss A M B Parker on small-radius cameras for rapid selection of single crystals and determination of their orientation, and by Dr W Wrazej on the examination of tempered martensite.

Dr. A J C Wilson reported on the progress of the

index of powder photographs which was started under the Institute's auspices soon after the 1942 Conference in order to supplement the index produced by the American Society for Testing Materials. He said that as a result of a search through papers published during 1925-39, and of the response by the British Museum and many industrial laboratories to a general appeal, the X-ray data for 1,200 more substances had been collected and sent to America for publication by the American Society for Testing Materials. The supplement to the Index would soon be available and annual supplements are to be issued.

Laboratory Equipment

The afternoon session on April 12 was devoted to a discussion of laboratory equipment. The outstanding feature was a demand for the preparation of standard specifications for many types of instruments such as high-temperature, long-spacing and other X-ray cameras, microphotometers, X-ray tubes, etc. Standard specifications for a powder camera have already been prepared by the X-ray Analysis Group Committee. It is recognized that such standard equipment, if made, will not be final, and work will still have to be able to improvise.

Dr R. F. Hanstock described an industrial laboratory equipped primarily for the determination of residual stresses in fabricated aluminium alloy. Special devices for mounting specimens up to 3 in diameter are provided. The specimen-to-film distance is obtained by smearing vacuum-annealed silver powder on the specimen surface, and it is estimated that the stress is obtained to an accuracy of better than 1 ton/sq in. Geiger counters have been found satisfactory for recording positions of X-ray diffraction maxima.

Mr H S Peiser began his talk by enumerating the types of problem which are dealt with in industrial crystallographic laboratories, namely (1) identification, (2) semi-quantitative analysis, (3) molecular weight and shape, (4) crystal structure, (5) texture. Some possible modifications to Astbury's design of a rotating anode tube³ were mentioned, and some details of a home-made gas tube given. It can be shown that a hot-cathode demountable tube gives a slightly more intense beam than the cold-cathode tube, though it is less efficient, and gives more white radiation. He stressed that reasonable care should be taken to safeguard the health of X-ray workers.⁴

Dr W A Wooster discussed some methods other than those of X-ray diffraction which are of use in the study of crystals. Information leading to a determination of symmetry class can be obtained from (1) interfacial angles, (2) etch figures, (3) refractive indices, (4) optical anisotropy, (5) piezo- and pyroelectric phenomena. The flotation method for density measurement was mentioned, as was also the determination of molecular orientation from measurement of variation of diamagnetic susceptibility with direction. He described also two methods of measuring peak voltage, one using the minimum wave-length, and the other a potential divider and cathode-ray oscillograph.

Interpretation by Optical Principles

Both sessions on April 13 were devoted to a discussion of the interpretation of X-ray diffraction means of optical principles. The four main contributions were from Sir Lawrence Bragg, Dr H Lips

Mr G B Hey and Prof J M Robertson Sir Lawrence Bragg summarized his paper as "a little of the history and some elementary book-work". He outlined the development of Fourier methods from the first tentative suggestion made by his father⁵ in 1915 to an actual synthesis by Havighurst⁶ in 1925. The book-work was an elementary treatment of Fourier synthesis⁷ and of the Patterson method, to provide a basis for the practical applications following in other papers. He concluded by describing how Fourier summations can be done optically, thus obviating tedious calculations⁸.

Dr Lipson then described some successful applications of Fourier methods. The fundamental difficulty is to obtain the signs (or the relative phases) of the structure amplitudes. This difficulty can be overcome if the structure contains a heavy atom (copper phosphate pentahydrate⁹, phthalocyanine¹⁰), or forms part of an isomorphous series (the alums¹¹), or if the distance between the constituent molecules can be determined suitably (horse methæmoglobin¹²).

In the afternoon, Mr Hey presented a paper by Mr L J Comrie and himself on methods of calculation. The most important requirements are efficiency and ease of checking. The methods developed by crystallographers are in general efficient, but little attention has been paid to checking. Repeating the calculation is a slow and uncertain check. Two safer methods are differencing and cross-summation, and Mr Hey gave details of their application. He concluded by suggesting modifications making the methods more suitable for use by professional computer not expert in crystallography, and describing the least-squares method of refining approximate structures¹³.

Prof Robertson then spoke on the significance of the results obtained by Fourier syntheses. It is theoretically possible for two structures to give identical diffraction patterns¹⁴, and therefore structures should be tested by all other available methods before being finally accepted as true. A check on the correctness of structures is the comparison of interatomic distances found by X-ray analysis with those found by other methods. Such comparisons of carbon-carbon distances indicate that an accuracy of about 0.2 Å is attainable in fixing atomic positions. He concluded by describing the structure of coronene, and mentioning some theoretical implications of the variations found in the carbon-carbon bond-length. A lively discussion followed each of these papers. It is hoped to publish a fuller account of the papers and the discussion in the *Journal of Scientific Instruments*.

Future of X-Ray Analysis

An extremely interesting and inspiring talk on the future of X-ray analysis in the form of an evening lecture was given on April 12 by Prof J D Bernal. He spoke first of the advances which may be expected to take place in fundamental studies when the war-time interruption comes to an end. All basic structure types are now well established, and lines of research will branch out in one direction towards more complicated structures, largely of biological interest, and another towards the elucidation of imperfect crystal structures.

Tools essential to these studies, such as extremely efficient X-ray tubes, and calculating devices of great intricacy, will almost certainly be developed as a result of advances in other fields in physics.

A far greater part will be played by the ever-

increasing use of X-rays as an auxiliary tool in scientific research in other fields. Such use of X-rays has gone ahead during the War, as can be seen from the great success of the Institute of Physics meetings, and the Cambridge Summer School. In order that this research tool should be of the greatest possible use, it must be combined with other techniques such as spectroscopy and microscopy including the electron microscope. A considerable number of research and training schools will be required if there is to be available a sufficient number of trained X-ray crystallographers. In order that this branch of science as a whole shall continue to advance, the connexion between the theoretical and applied fields must always remain as close as, or closer than, it is to-day.

Prof Bernal dealt also with the problem of centralization of publication, and with international co-operation.

Exhibition

In addition to the discussion, an exhibition of X-ray photographs, apparatus and new books of interest to crystallographers was arranged. Several makes of powder cameras and single-crystal rotation and oscillation cameras were on show. There was an ionization spectrometer and a two-crystal moving-film goniometer for the determination of absolute intensities. A back-reflexion camera was exhibited in which the film can be rotated on a ball-race instead of using the collimator itself as a bearing. A new design of goniometer head gives a very wide range of angular adjustment, and can be easily transferred from one suitably fitted camera to another.

A machine for calculating structure factors for one atom was demonstrated, and it was suggested that with a series of these machines it would be possible to calculate structure factors for up to fifteen atoms per unit cell. A very elegant bent-quartz monochromator was shown, with which a relatively very intense convergent crystal-reflected beam is obtained. There was also a demonstration of quartz crystals, and the manner in which they are cut for use in piezo-electric oscillators. Of particular interest to those who wish to make structure models was a special jig for drilling wooden balls, and a new form of clip for holding them securely together. The new books included "The Structure of Metals" by C S Barrett (McGraw-Hill), "X-Ray Crystallography" by M J Buerger (Wiley), and an "Introduction to X-Ray Metallography" by A Taylor (Chapman and Hall, in the press). There were also photo-lithoprint reproductions of some books published in Germany, including "Röntgenstrahl-Interferenzen" by M von Laue and "Internationale Tabellen zur Bestimmung von Kristallstrukturen".

¹ *J. Sci. Instruments*, 22, 57 (1945)

² Frommer, L., and Lloyd, E. H., *J. Inst. Met.*, 70, 91 (1944)

³ *J. Sci. Instruments*, 22, 68 (1945)

⁴ Recommendations of the X-Ray and Radium Protection Committee, 32 Welbeck Street, London, W 1

⁵ Bragg, W. H., *Phil. Trans. Roy. Soc.*, 215, 253 (1915)

⁶ Havighurst, R. J., *Proc. Nat. Acad. Sci.*, 11, 502 (1925)

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SPIN IN THE UNIVERSE

SIR EDMUND WHITTAKER discussed "The Spin of the Universe" in his presidential address to the Royal Society of Edinburgh at the annual statutory meeting held on October 23, 1944 (Year Book of the Royal Society of Edinburgh, 1945).

Starting with Earl Rosse's discoveries of spiral nebulae, the first of which was *M* 51 (although examined previously by several astronomers the much greater resolving power used by Lord Rosse showed its spiral character for the first time), Whittaker proceeds to examine the cosmological significance of rotation and spin characteristics of the spiral nebulae. He refers to the theory propounded by H. Alfvén (*Ark Mat, Astr, och Fys*, 28 A, No 6, 1942), which accounts for the angular momentum possessed by the planets of the solar system (a short outline of this theory appeared in *Nature*, 150, 405, Oct 3, 1942, and 152, 721, Dec 18, 1943). Alfvén's theory would apply to the stars as well as to the sun, and would lead us to assume that a star is generally accompanied by a family of planets—a view corroborated by recent discoveries of planets associated with other stars. His theory shows how spin can be acquired by material bodies under the action of electric and magnetic fields, or, in other words, spin can be transferred from ether to matter, and hence it is natural to inquire whether anything is known about spin or angular momentum in the ether.

Since the discovery of the theory of relativity, the ether has been discarded except as the name of an invisible transmitter of actions at a distance, and the ether theories have been replaced by the new science of atomic physics. How has the change, in which the fundamental entities are elementary wave-particles or corporundals of certain kinds, affected our conception of invisible spin? Within the last two decades it has been found that each of these elementary particles possesses a certain definite quantity of spin, and this is of great importance in determining the behaviour of the particle. A short description of *quantum numbers* is followed by an account of the discovery in 1925 that a third quantum number is required to describe an electronic level, a discovery which immediately led to the question, "To what physical character of the atom does this new third quantum number correspond?" Reasons were soon forthcoming to suggest that this third number corresponded to the total spin of the whole atom, just as the second quantum number represented the angular momentum or spin of the orbital motion of the electron, and it was shown that it was not the spin of the nucleus but of the electron which took place.

A study of the Zeeman effect led to the conclusion that the angular momentum or spin of the electron is $\frac{1}{2}h$, where h is Planck's constant of action divided by 2π , and that the electron has a certain fixed magnetic moment associated with the spin. It is impossible to verify the spin and magnetic moment by direct observation, owing to the uncertainty principle, and the phenomenon of electron-spin belongs to quantum theory, for which reason it possesses peculiarities not met with in classical dynamics. It is a quantum-mechanical entity, and when we speak of its component in the direction of the *z*-axis, say, the only meaning attached to the statement is that there is a certain probability that the axis of spin will be parallel to the *z*-axis and the spin-component of amount $\frac{1}{2}h$, and also the probability that the axis of spin will be antiparallel to the *z*-axis, the spin

component being now $-\frac{1}{2}h$. It has been found that each of the other elementary particles also possesses a definite amount of spin, the proton, the neutron and the positron can each have the same spin as the electron, $\frac{1}{2}h$, while the photon or light corpuscle has the spin h , and the spin of the meson may have either of the values 0 or h .

Whittaker refers to the important part that the spin of the elementary particle plays in chemical combination and to its influence on what is called the statistical behaviour of the elementary particles, and deals briefly with the Maxwellian statistics, the Fermi statistics, and the Bose statistics, generally recognized under the composite titles, Maxwell-Boltzmann, Fermi-Dirac and Bose-Einstein, but it is impossible in a limited space to deal with every feature of the address. One important matter may be mentioned. The correlation between the particle and the wave properties of the elementary particles has been long known, so far as concerns energy, momentum and velocity, and the question arises, "What feature of the waves is to be interpreted as spin?" Sir Charles Darwin discovered the true solution in 1927, and concluded that the wave-aspect of spin was simply the capacity to exist in different states possessing the same energy and momentum, analogous to differently polarized waves of light. In 1928 Dirac found the wave equation of the electron in a form which was invariant under all the transformations associated with the principle of relativity, and spin appears to be a consequence of the symmetry of the cosmos with respect to space and time. The concept of spin thus emerged in a new light, it had originated in atomic physics, and it was now lifted into a new context, that of relativity theory.

Relativists had directed their attention for many years to the remarkable difference existing, as regards relativity, between motions of translation and of rotation. According to the principle of relativity, it is impossible by observational means to detect uniform motion of translation which occurs wholly within the system, but the case is quite different as regards rotation. We can speak of velocities of rotation in an absolute manner, without specifying the framework with respect to which the angular displacement takes place. Certain problems in the relativity theory of spin arise, to which reference is made, and some of these are still controversial. As Whittaker points out, the study of rotation is essentially a cosmic problem, and attempting to solve it we are brought back to the spiral nebulae. It seems probable that their inner regions rotate as if rigidly connected, the linear velocity increasing with the distance, while in the outer parts the linear velocity decreases with increasing distance. Prof. E. A. Milne has proposed an explanation of the rotation of the spiral nebulae as of the possession of spin by most large objects and groups of objects in the universe. He has deduced from his kinematical relativity that the angular momentum of any cosmical system increases proportionally to the time, that is, to what he calls *kinematic time*, which is time as measured by atomic vibrations and radioactive clocks. Hence a spin which was initially small will grow continually greater, and there is therefore nothing surprising in the existence of large accumulations of angular momentum. No theory to explain spin in the universe has yet been generally accepted, but it is reasonable to hope for a solution of this fundamental problem of cosmology in the near future.

MARINE ECOLOGY AND THE FISHERIES

WITH the present two numbers of the *Hull Bulletins of Marine Ecology*, volume 1 is complete*. Of volume 2 four numbers are already published and three are in the press. Prof A C Hardy, editor of these bulletins, in his explanation at the beginning of volume 1 gives an excellent simplified résumé of the whole. Ecology as he defines it "is establishing the relationship between a creature and its surroundings in terms of quantity." He sketches the gradual growth of marine ecology with admirable clarity, its scope, early history, and the beginning of the work at Hull leading to all these researches. This work, planned by himself and successfully carried out, includes his invention of the plankton indicator and, following this, the plankton recorder, both of which have proved to be of real help to the fishery industry. Here a story is told in the simplest terms which is of special interest and importance. It has always been Prof Hardy's aim to bring science and industry together. How successful he has been is shown in the tributes paid to him by the skippers of the vessels which have his apparatus in use.

His explanation proceeds to summarize each bulletin in volume 1. Again, as simply as possible, the contents of each part are explained, with clear diagrammatic illustrations of apparatus and of planktonic organisms. This is an excellent method of introducing the work to non-specialists.

No 6, concerned with the main plankton survey, deals with the monthly changes in the zooplankton other than Copepoda and young fish as shown by the plankton recorder. Here the seasonal changes are much in evidence, and the distribution of *Sagitta*, *Amacina*, *Clione*, Lamellibranch larvæ, *Cladocera*, *Amphipoda*, Decapod larvæ, Echinoderm larvæ and *Oikopleura* is shown in series of monthly charts, while the seasonal fluctuations are compared in time-chart histograms.

These researches have been suspended for the present, but it is hoped that they may be developed in several directions for a long period in the future.

* *Hull Bulletins of Marine Ecology*, edited by Prof A C Hardy and R C E Lucas. Vol 1, pp 1-111, October 1944, 3s. Title Page, Contents Table, List of Personnel, Preface and Explanation. Vol 1, no 6, pp 255-275, Plates cxvii-cxlv. July 1944, 4s. Continuous Plankton Records. The Zooplankton (other than Copepoda and Young fish) in the Southern North Sea, 1932-37, by Dr G T D Henderson and N B Marshall.

THEOLOGY IN AN AGE OF SCIENCE

IN his inaugural lecture at the University of Oxford on November 3, 1944 (Oxford At the Clarendon Press, 2s net), Prof Leonard Hodgson, regius professor of divinity, asked how the voice of theology is to be heard in a scientifically minded age. Must it not inevitably belong to a world of thought alien to the scientific outlook?

Science has been defined by Dr C H Waddington as "the organized attempt to discover how things work as causal systems." This view assumes that all events are explicable in terms of causal systems (or that there are no events lying outside the range of scientific study). In this case, does the fact that psychologists and sociologists are recognized as men

of science mean that all human behaviour can be accounted for on causal grounds? Or that they can study only such aspects of it as are thus causally explicable?

To take the former view is to beg a very large question, to take the latter is to assert that there can be no scientific study of such purposive behaviour as is explicable in terms not of causes but of reasons—a limitation which psychologists and sociologists would reject.

The fact is remarks Prof Hodgson, "we live in a world in which there are two orders of events—those which follow from causes, and those which are done on purpose, for reasons." Thus, if science limits itself strictly to the causal order it can only deal with one part of our experience.

If theology is a science, it would presumably deal with a subject-matter not dissimilar to those of psychology and sociology, that is, events which are done on purpose, for reasons.

Rejecting the traditional idea of revelation as "erroneous and untenable", Prof Hodgson declares that "the divine revelation is not given in the form of propositions conveying a ready-made knowledge, but in events which are divine redemptive acts." These acts, and the evidence for them, it is the business of theology to study, and here lies its claim to be a science.

"Theology is itself one of the sciences—the empirical study of the evidence for certain mighty acts of God in the history of the world."

To be scientific, such studies would have to be wholly unprejudiced. Of course the evidence for some of these events, and these not the least important, is not easy to establish and it is perhaps not justifiable to speak of these events, as Prof Hodgson does, as "a certain sequence of events which, as events, are as observable as any others."

Theology then would appear to be a science in the same sense as history is one. But to divest theology of its philosophical aspects would be to divest it of most of its interest and depth.

RESOLUTION OF EXTRAGALACTIC NEBULÆ

UNLIKE the other nebulae in the local group, the two companions of the Andromeda nebula—M 32 and NGC 205—and the central region of the Andromeda nebula itself, have hitherto defied resolution into stars by the most powerful instruments at the disposal of astronomers. It was therefore supposed that the luminosity of their brightest stars was abnormally low. This conclusion is amply confirmed by the resolution of these objects on plates taken recently on the 100-in telescope (W Baade, *Astrophys J.* 100, 137, 1944).

Some time ago, unexpected signs of incipient resolution on ordinary plates taken under good conditions gave grounds for hoping that further refinements of technique would lead to complete resolution. This has now been achieved by the use of red-sensitive plates behind a filter passing only the region 6300-6700 Å, so as to avoid the strong night-sky emission. Only nights of exceptional definition were used, and only these if the temperature variations were such as to minimize changes of form of the 100-in mirror. The plates were obtained with exposures of the order of four hours, and show that

the hitherto amorphous structure of these galaxies has disintegrated into a great number of faint red stars close to the threshold limit of the plates

This behaviour is quite unlike that of the hitherto resolvable systems, in which the brightest stars are white and are relatively rare Baade believes that the galaxies contain two types of stellar population differing in their Hertzsprung-Russell diagrams. Type I contains *O* and *B* supergiants and open clusters, and is exemplified by the slow-moving stars in the solar neighbourhood, type II, exhibited pure only in early-type nebulae, contains short-period Cepheids and globular clusters. Both types co-exist in our own galaxy.

This new technique for resolving extragalactic nebulae by employing red-sensitive plates in the best observing conditions with the 100-in telescope has also shown that even early-type nebulae can be resolved if their distance does not exceed 300 kiloparsecs. Since this is the distance usually taken to mark the boundary of the 'local group' of galaxies, the criterion of resolvability becomes the test of membership of the local group. This test, applied by Baade (*Astrophys J*, 100, 147, 1944) to NGC 147 and to NGC 185, shows that these inconspicuous companions of the Andromeda nebula are local galaxies best classified as elliptical nebulae of low luminosity and small density gradient. These additions increase the number of recognized members of the local group from eleven to thirteen, and dwarf galaxies now outnumber giants by two to one.

The proportion of elliptical systems is steadily rising as a result of recent discoveries: they now number nearly a half of the known local nebulae. The new data do not support the view that globular clusters and elliptical nebulae lie at opposite ends of a common sequence of stellar agglomerations. The biggest globular clusters are still some ten times smaller in linear dimensions than the smallest elliptical nebulae, and the mean densities of the two systems differ by a factor of the order of fifty.

FORTHCOMING EVENTS

Monday, May 28

BRITISH PSYCHOLOGICAL SOCIETY (INDUSTRIAL SECTION) (at the London School of Hygiene and Tropical Medicine, Keppel Street, London, W C 1), at 12.45 p.m.—Prof C A Mace "Industrial Training or Industrial Education?"

Tuesday, May 29

ROYAL COLLEGE OF SURGEONS (Lincoln's Inn Fields, London, W C 2), at 4 p.m.—Prof Arnold Sorsby "Penicillin and Gramicidin in Ophthalmology"

EUGENICS SOCIETY (at Royal Society, Burlington House, London, W 1), at 5 p.m.—Mr Cyril Bibby "Sex Education—Aims, Possibilities and Plans"

TELEVISION SOCIETY (at the Institution of Electrical Engineers, Savoy Place, Victoria Embankment, London, W C 2), at 6 p.m.—Dr W Sommer "The Human Eye and the Photo-Cell"

Wednesday, May 30

ROYAL SOCIETY OF ARTS (at John Adam Street, Adelphi, London, W C 2), at 1.45 p.m.—Dr Colin G Butler "The Behaviour of Bees when Foraging"

SOCIETY OF CHEMICAL INDUSTRY (PLASTICS GROUP) (at the Royal Institution, Albemarle Street, London, W 1), at 3 p.m.—Mr H V Potter "Leo Hendrik Baekeland: The Story of His Life" (first Baekeland Memorial Lecture)

PHYSICAL SOCIETY (COLOUR GROUP) (at the Royal Photographic Society, 16 Prince's Gate, London, S W 7), at 3.30 p.m.—Mr L C Jesty "Colour Television"

Thursday, May 31

INSTITUTE OF FUEL (at the Institution of Mechanical Engineers, Storey's Gate, St James's Park, London, S W 1), at 10.30 a.m. and 2.30 p.m.—Conference on "Industrial Thermal Insulation" (to be opened by Dr E W Smith, C B E)

ROYAL AERONAUTICAL SOCIETY (at the Institution of Mechanical Engineers, Storey's Gate, St James's Park, London, S W 1), at 6.30 p.m.—Mr T P Wright "Aviation's Place in Civilization" (Thirty-third Wilbur Wright Memorial Lecture)

Friday, June 1

ROYAL INSTITUTION (at 21 Albemarle Street, London, W 1), at 5 p.m.—Prof James Gray, F R S "Migration of Animals"

INSTITUTION OF MECHANICAL ENGINEERS (at Storey's Gate, St James's Park, London, S W 1), at 5.30 p.m.—Exhibition of Film of Engineering Interest

GEOLOGISTS' ASSOCIATION (at the Geological Society of London, Burlington House, Piccadilly, London, W 1), at 6 p.m.—Prof Austin Miller "Some Physical Features of the Dolgelly District"

APPOINTMENTS VACANT

APPLICATIONS are invited for the following appointments on or before the dates mentioned.

LECTURER IN ORGANIC CHEMISTRY at the City of Liverpool Technical College—The Director of Education, 14 Sir Thomas Street, Liverpool 1 (June 1)

LECTURER IN PHYSICS at Loughborough College, Leicestershire—The Registrar (June 7)

TUTOR, and ASSISTANT TUTOR, in the DEPARTMENT OF SOCIAL SCIENCE, London School of Economics and Political Science—Acting Secretary, at the Hostel, Peterhouse, Cambridge (June 8)

LECTURER IN RUBBER TECHNOLOGY at the Northern Polytechnic, Holloway Road, London, N 17—The Clerk (June 13)

DIRECTOR OF RESEARCH at the Institution of Automobile Engineers—Research Department of the Institution, Great West Road, Brentford, Middlesex, marked "Director of Research" (June 16)

ASSISTANT LECTURER IN ANATOMY, London (Royal Free Hospital School of Medicine for Women, Hunter Street, Brunswick Square, London, W C 1—The Warden and Secretary (June 23)

PROFESSOR OF PHYSIOLOGY at King's College of Household and Social Science—The Academic Registrar, University of London, Richmond College, Richmond, Surrey (June 26)

METALLURGIST in Midlands for research work on cemented carbide—The Ministry of Labour and National Service, Central T and S Register, Room 5/17, Sardinia Street, London, W C 2 (quota F 4005 XA) (June 30)

READER IN ENTOMOLOGY in the University of Durham, tenable at King's College, Newcastle-upon-Tyne—The Registrar of King College (June 30)

PROFESSOR OF INDUSTRIAL HEALTH in the University of Durham, tenable at the Medical School, King's College, Newcastle-upon-Tyne—The Registrar of King's College (July 31)

FELLOWSHIP IN ECONOMICS at Balliol College, Oxford—The Master Secretary (Aug 31)

VICE-PRINCIPAL (woman) of Wye College (University of London) with experience in university teaching in science, horticulture, agriculture or economics—The Acting Principal, Wye College, near Ashford, Kent

REPORTS and other PUBLICATION

(not included in the monthly Books Supplement)

Great Britain and Ireland

Imperial Bureau of Animal Health Review Series, No 2. Mode of Spread of Streptococcus Agalactiae Infection in Dairy Herds. Report on Co-ordinated Observations Organised by the Agricultural Research Council of the United Kingdom. Pp iii+28. (New Haverley, Weybridge. Imperial Bureau of Animal Health, 1944) 3s

Institution of Electrical Engineers Report of the Council for the Year 1944-1945. Pp 12. (London: Institution of Electrical Engineers, 1945)

Carnegie United Kingdom Trust Thirty-first Annual Report for the Year 1944. Pp 8. (Dunfermline: Carnegie United Kingdom Trust, 1945)

John Innes Horticultural Institution Thirty-fifth Annual Report for the Year 1944. Pp 24. Bulletin No 1. Answers to Growers. Pp 60+8 plates. 2s 6d. (London: John Innes Horticultural Institution, 1945)

Other Countries

Transactions of the San Diego Society of Natural History Vol 1 No 10. A New Race of Kangaroo Rat from the Argus Mountains, California. By Laurence M Huey. Pp 131-132. Vol 10, No 11. The Geckos of the Genus Coleonyx with Descriptions of New Species. By Laurence M Klauber. Pp 133-216. (San Diego: Calif. San Diego Society of Natural History, 1945)

Zoological Society of San Diego Publication No 21. Herpetological Correlations. 1. Correlations in Homogeneous Populations. I. Laurence M Klauber. Pp 101. (San Diego, Calif. Zoological Society of San Diego, 1945)

Transactions of the Mining, Geological and Metallurgical Institute of India Vol 39, No 4. A Contribution to the Study of Ordovician Carbon and Medium Manganese Steel Rails. By J S Vatchegandl and Dr G P Contractor. Pp vi+200+14 plates. Vol 40, No 1. The Course of Recent and Future Developments in the Steel Trade in India. By R A Macgregor. Pp 24. (Calcutta: Mining, Geological and Metallurgical Institute of India, 1944)

Indian Research Fund Association. Special Report No 12. Studies on Basal Metabolism in India. By Dr V N Patwardhan. Pp 2. (Cawnpore: Job Press, 1944) 6 annas

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THE SCIENCE OF HUMAN RELATIONSHIPS

"If civilization is to survive," wrote President Roosevelt in a speech to have been delivered in Washington at the Jefferson Day Dinner on April 12, "we must cultivate the science of human relationships, the ability of all peoples of all kinds to live together and to work together in the same world at peace." That last message shows that President Roosevelt was looking to the San Francisco Conference, of which he was to have been chairman, as a great essay in the science of human relationships, and it may indeed be true that an end to wars will only be in sight when we develop that science and perfect our understanding of human relationships in organizations that satisfy their needs more perfectly. This point of view was well put by Dr J T MacCurdy in "The Structure of Morale", and if there is to be in any true sense a science of peace its basis may be rather the development and application of biology and the social sciences, including psychology, as Prof Anton J Carlson suggested in his address "The Science of Biology and the Future of Man" (see *Science*, 100, 437, 1944), for example, than an approach from the economic side, the scientific study of history or the application of scientific method to disarmament.

This is not to say that the latter may not have their place, but attempts at the scientific study of international relations such as Prof E H Carr set out to give in "The Twenty Years Crisis" have not yet led very far. Indeed, from his latest book*, Prof Carr seems to have abandoned the effort to outline a science of international politics. His study of nationalism is too brief to be more than perfunctory, and roughly half the book is occupied by a discussion of the prospects of internationalism, this, although the scientific approach is abandoned, is highly pertinent to discussions on the Dumbarton Oaks proposals and the proceedings at San Francisco.

Prof Carr's sketch of the rise of nationalism from the sixteenth and seventeenth centuries to its climax between 1914 and 1939 in the totalitarian State attributes the latter to three factors: the socialization of the nation, or the bringing of new social strata into the effective membership of the nation; the nationalization of economic policy, and the geographical extension of nationalism as seen in the increase in the number of nations. That last factor, especially in relation to the principle of self-determination, Prof Carr has already closely analysed in "Conditions of Peace", and his discussion of the prospects of internationalism is no less realistic in the present volume. He challenges and rejects forthright the claim of nationalism to make the nation the sole rightful sovereign repository of political power and the ultimate constituent unit of world organization. He equally challenges the principle of "the sovereign equality of all peace-loving States" of the Moscow Declaration of October 1943, which although embedded in the Dumbarton Oaks proposals is, as was

* Nationalism and After By Prof Edward Hallett Carr. Pp vi+74 (London Macmillan and Co., Ltd., 1945) 3s 6d net

pointed out in the recent debate, by no means consistent with that scheme, apart altogether from the vexed question of the voting formula.

Within its limits, Prof. Carr's little sketch and analysis is a sound contribution to lucid thought about the Dumbarton Oaks scheme, and a number of his points were emphasized in the debate in the House of Commons on April 17. The right of equality, like the right of freedom, he holds, is one that can only be attributed to individuals, not to nations, the equality of nations is not only unattainable, but also neither equitable nor desirable. Like the Grotius Society and M. Lauterpecht in "The Law of Nations, the Law of Nature and the Rights of Man", Prof. Carr comes down firmly on the side of the individual. "The driving force behind any future international order," he writes, "must be a belief, however expressed, in the value of individual human beings irrespective of national affinities or allegiance and in a common and mutual obligation to promote their well-being."

Prof. Carr does not, however, visualize a supreme world directorate as an immediate objective, the sense of unity of mankind is not yet strong enough to sustain such an authority. While a world organization may be a necessary convenience and a valuable symbol, the intermediate unit is more likely to be the operative factor in the transition from nationalism to internationalism. The same caution is applied to schemes of world-wide economic organization. Nations have ceased to be convenient or even tolerable units for this purpose, and the world is not yet ready for a single comprehensive world unit. Meanwhile, the socially and internationally descriptive tendencies inherent in a multitude of planned national economies must be countered by multi-national and international planning.

As to the size and nature of such intermediate units, Prof. Carr points out that they should be appropriate for the particular end in view, and accordingly he welcomes the functional principle and the development or extension wherever appropriate of the numerous agencies of this type set up to serve the war purposes of the United Nations. Moreover, he holds that bodies like the United Nations Relief and Rehabilitation Administration and the Food and Agriculture Organization, which have been conceived on a universal basis, will be effective only in so far as they create separate organs for specific purposes in different areas. Part of the value of such functional bodies lies in the fact that, operating on national territories with the tacit or explicit consent but not formally derived authority of the national governments concerned, operating without regard to divisions or distinctions between different countries, and without affecting the sovereign powers of the national governments, they foster that multiplicity of authorities and loyalties which is essential to the health both of an international and of a national community.

This view of a developing organism rather than of a created mechanism is reflected in American opinion quoted by Prof. Carr, and seemed to be the dominant attitude to the Dumbarton Oaks proposals as expressed in the recent debate in both Houses of

Parliament. It was very clear that the scheme for Security Council was accepted only as the best that could be obtained at the moment. At the same time as Sir George Schuster pointed out, we need not assume that there will always be disagreement between the Great Powers, though it would indeed be foolish to assume that Great Britain, the United States and the U.S.S.R. will always see eye to eye on international questions of every description. It should be remembered that the peace settlement will be made, not by the new organization proposed at Dumbarton Oaks, but by the victorious belligerents and that, as Sir Arthur Salter pointed out, for about five years at least, the main interest in the international political sphere will be in the peace settlement organization of the United Nations, and also all in Britain, the United States and the U.S.S.R. In those years they can, as Mr. Churchill has expressed the hope and conviction, work together for the establishment of world peace and order and demonstrate that they can use their power to serve all nations. An entirely different attitude may prevail towards the present proposals when the Security Council really becomes effective.

Sir Arthur Salter was urging that too much should not be expected of the new organization at the start and that the limits of its responsibilities should be clearly and widely understood, so as to avoid disillusionment and loss of prestige when the new organization begins to function. For the same reason, the voting procedure may well be accepted as a temporary measure, provided it is open to revision and modification in the light of experience.

Although there was clear realization that the deliberations at San Francisco are unlikely to lead directly to a new world State, to a world police force or to federal Europe, the importance of the Conference and of agreement was fully appreciated also. Prof. Carr's prediction that the world would have to accommodate itself to the emergence of a few great multinational units in which power will be mainly concentrated—units, which culturally may best be called civilizations—was indeed tacitly assumed as correct though the solution he suggests to the dilemma of national self-determination, namely, an attempt to divorce international security and the power to maintain it from frontiers and the national sovereignty which they represent, was not mentioned. Very clearly, however, it was hoped that the habit of co-operation and common action by the Great Powers would tend to remove a predisposing cause of conflict between them, but the whole sense of the debate was with Prof. Carr in his affirmation that no international organization of power will endure unless it rests on certain common principles and pursues certain common purposes, worthy of commanding assent and loyalty of men and women throughout the world. The unifying power of the ideal of social justice in the contemporary world was well brought out by Sir George Schuster, who sensed the opportunity for leadership now awaiting Great Britain. The importance of a vigorous domestic policy in promoting understanding and *rapprochement* with the Soviet Union was also emphasized.

The conception of a balanced structure of international or multi-national groupings both for the maintenance of security and for the planned development of the economies of geographical areas and groups of nations, which Prof. Carr sees as the best prospect of international advance, has thus a good deal of general support, and readers of his book would be able to follow the San Francisco proceedings the more intelligently for its discerning treatment of some of the fundamental issues. But, like Prof Carr's impatience of nationalism makes him dismiss its claims a little too lightly, nationalism has a doughty champion in the House of Commons Sir William Beveridge. Sir William rated public opinion as of no practical importance for the prevention of aggression, but after agreeing on the difference in strength between nations and the necessity of winning the confidence of all nations in world organization, defended the idea of sovereignty and of collective security.

In doing so, Sir William essentially elaborated the argument of his book, "The Price of Peace", emphasizing the importance of establishing the rule of law for all nations. The gist of his thesis is that the abolition of war depends on finding a positive alternative to war as a means of settling disputes between nations. The only alternative which can be world-wide is compulsory arbitration by an impartial tribunal, applied to all disputes and backed by overwhelming force.

In Sir William's speech in the House of Commons he has revealed more clearly than his book the difficulties into which his legalistic rather than realist approach leads.

That alone can account for his sponsoring the legalism which, at the outset of his book, he fully rejects in so far as it is expressed in sovereignty. Indeed, his real starting point is that from which Lionel Curtis starts in his "World War—its Cause and Cure"—to which, incidentally, Sir William

tributes a foreword—Lord Lothian's Bursell Memorial Lecture and his subsequent speech to the House of Delegates and Senate of Virginia on February 17, 1940, as British Ambassador. "To-day anarchy of sovereign States cannot escape chronic or preserve individual liberty or create the conditions of prosperity or employment within their boundaries unless, in some way, they can bring themselves collectively under the reign of a single constitutional law."

With that text, Mr. Curtis has put together the substance of his earlier pamphlets. "Action", "Discipline", "Faith and Works" and "The Way to Peace", but it cannot be said that the work has been skilfully done. There is some repetition, and the argument has scarcely been improved in the process or by his diversions into history and other subjects. Mr. Curtis's sincerity and conviction cannot be mistaken, but they, like his argument, stand out in the pamphlet form in which they were first put to us. That is unfortunate, for Mr. Curtis's attitude regarding imperial defence, on which his pro-

he Price of Peace. By Sir William Beveridge. Pp 104. London: Pilot Press, 1945. 6s. net.
World War—its Cause and Cure. By Lionel Curtis. Pp xx+274. Oxford: Oxford University Press, 1945. 7s. 6d. net.

posed federal scheme is based, remains unanswered, and there is no indication as yet that that issue was really faced at the recent British Commonwealth Relations conference. If it must be recognized that there are limitations to what can be achieved at San Francisco, the very arguments regarding flexibility and an experimental and provisional approach, which were heard in Parliament, are the more reason why the British Commonwealth should make a further attempt to deal with its own problem and give the world a demonstration of the way in which a solution may be found to the larger problem.

Sir William Beveridge's legalistic approach was severely handled by Mr. Richard Law in concluding the debate in the House of Commons, but Sir William's view that the world order of to-morrow must be built on compulsory arbitration of all disputes does not constitute the sole feature of his book. Apart from the merits or demerits of his own suggestion, for which he himself disclaims any idea of novelty, pointing out that it was the basis of the Geneva Protocol, the first part of his book is a well-documented account of the experience of the last thirty years, which in itself should help many to form an independent and objective opinion on the Dumbarton Oaks scheme. It is when he passes on to discuss the conditions and methods of peace, and the scope and nature of a supernational authority, that Sir William becomes too formal and tends to overlook the necessity for a process of adjustment, compromise and agreement between those in whose hands power at present resides.

Mr. Law rightly pointed out that such processes and the establishment of confidence go to the building up of a real system of international law as well as of one of security, and he was able to some extent to reassure the House as to the qualifications which were attached to the right of veto of the Great Powers in the Yalta agreement. Mr. Law concealed no difficulties, but like Sir George Schuster he looked rather to the opportunities opening before us at San Francisco and at the inescapable fact that the only alternative to agreement and success is international anarchy, with all the implications which the closing stages of the War gave to that situation. As Lord Cranborne put it: "To-day we have another chance—it may be the last—to lift humanity out of the pit into which it has fallen. We must not, we dare not fail."

On the success of that effort depend not merely the material welfare of mankind but also the continued advance of science and every other cultural and creative activity. Moreover, though few will entertain false hopes as to the outcome of the deliberations at San Francisco or as to the immediate possibilities of whatever international organization may be set up as an outcome of that Conference, we may well reflect that we may be witnessing the approach to a science of international relationships. It is not merely that we may use organizations set up during the War for peace-time purposes, and thus promote the good will and understanding upon which international co-operation in any field, technical or political,

depends. Sir Arthur Salter has strongly urged the value of the wise use, for example, of the United Nations Relief and Rehabilitation Administration under the direction of a Supreme Reconstruction Council, and others besides him pointed out how relief work could stimulate the integration of the cultural and spiritual as well as the material side of European life. Viscount Hinchinbrooke saw in the problem which Germany itself presents a unique opportunity for an experiment in international government, and there is much in the general attitude to the San Francisco Conference which justifies the belief that something of the method and spirit of science is penetrating into international affairs.

Much clear thinking will yet be required as to the nature and meaning of nationalism, and further study must be made of its problems and the ways and means of mitigating its dangers. But while more than public opinion is clearly required to prevent aggression, Sir William Beveridge is wrong to dismiss it as of no importance. Any world authority must rest upon the support of an informed public opinion, aware of the limitations as well as the possibilities of world organizations, and understanding the restraints which must be accepted as the alternative to anarchy. Part of the task of building a science of peace must be the creation by education of such a world opinion clearly understanding the price of peace. Out of such efforts, reinforced by the scientific investigation of human relationships, designed to encourage the development in due course of an intelligence system comparable with that of the human body, there may be slowly evolved a real science of international relations. Only then can we expect to shape more precisely the large regional and international organizations adapted to serve the needs of men of all nations. Until that time comes, it behoves all men of good will to attempt to appreciate the nature of the problem of international co-operation and its bearing on their own interest and activities both as citizens and professionally, and understanding, to lend their moral support to the efforts of those who at San Francisco or elsewhere are seeking to pave the way to a better and enduring world order.

OCEANOGRAPHIC INVESTIGATIONS

The Oceans

Their Physics, Chemistry and General Biology By Profs H U Sverdrup, Martin W Johnson, and Richard H Fleming. Pp x+1,087 (New York: Prentice and Hall, Inc., London: George Allen and Unwin, Ltd., 1944) 63s net.

SVERDRUP, Johnson and Fleming have answered the demand for an up-to-date manual of oceanography with a comprehensive work, "The Oceans: Their Physics, Chemistry and General Biology". It is a large book with 1,087 pages, amply illustrated by text-figures and charts. It was published two years ago in the United States, but circulation to Great Britain was restricted until the end of last year.

Progress in oceanographical research has been exceptionally rapid during the past twenty years and the reader is warned in the preface that such recent information must sometimes be coloured in presentation by the authors' own views. At the risk of premature generalizations, they have preferred definite statements to the enumeration of uncorrelated observations, though without failing to make proper reference to alternative explanations. The success of the book is unmistakable: it will be invaluable both to specialist and beginner. In its treatment of difficult problems it does not take too much granted, though tiresome over-simplification is avoided.

The authors insist on the close inter-relation of the different aspects of oceanography, and at the Scripps Institution, where the book was written, each aspect is represented by at least one good authority. It is fortunate for the future of oceanographical research that there was such a team, working in sufficient close co-operation to cover the whole field and achieve successful joint authorship. The Scripps Institution is on the Pacific coast near La Jolla, sixteen miles north of San Diego; it is a department of the University of California. It was founded and equipped by the Scripps family, who have been great benefactors in La Jolla, and derives its funds half from the State of California, and half from the Scripps Family Research. In all branches of oceanography is encouraged, each section has great freedom, and its own grant for equipment and library. The excellent situation, facilities and atmosphere make it an ideal place for research. Prof Sverdrup has been director since 1936, and Johnson and Fleming are assistant professors.

The rapid progress made during the past twenty years is attributed partly to improved technique and partly to the application of theoretical study and laboratory research, though the frequent insistence in the book on the need for additional observations shows that theoretical treatment is now of value ahead of the work at sea. There are problems which need intensive work by several vessels, and there is still scope for extensive exploration. Where measurements have been made synoptically, over a wide network of observation points, the irregularities of physical properties and water movements have proved much greater than was expected, and this shows that great caution must be exercised in drawing conclusions from scattered observations.

The biological chapters make a detailed survey of the factors which control distribution and fertility. It is maintained that animal and plant distributions are not haphazard, but result from orderly evolutionary processes, some historical and some in continual operation. Apparent lack of order is attributed to lack of information. It is emphasized that the distribution and fertility of any species cannot be studied satisfactorily without investigating the whole life-history from egg to spawning adult; each stage may have its own particular requirements.

One of the themes of the biological section is the excellent adaptation of the animals and plants to their environment, and the advantages of sea water as a medium for supporting life. Everything needed for the maintenance of life is carried in solution—necessary gases as well as the mineral substances—except in estuaries, the stability of the physical characteristics makes highly specialized integumentary or regulatory systems unnecessary. With few exceptions the marine animals from groups with firm

ter representatives are larger than their freshwater relatives, and usually the difference is enormous. An proved food supply and more favourable rate of metabolism must be mainly responsible. Respiration probably easier in sea water owing to the presence carbonates which facilitate the removal of carbon oxide, and since the osmotic pressure of sea water nearly the same as that of the body fluids, no special energy is needed to maintain the proper equilibrium. The gradients of temperature, salinity and light intensity in the sea afford, to those animals that are able to move up and down, the opportunity selecting optimum conditions. The authors summarize the latest information on all these aspects. The single-celled plants are shown to be adapted pelagic life by their microscopic size, and the consequent high ratio of surface area to volume and sinking-rate. Where necessary they have special structures and shapes, or oil particles, to retard sinking. The most specialized forms are found in the warmer waters, and are associated with the lower viscosity of the warmer waters. It is the microscopic plants which make possible the population of large stretches of ocean, the larger plants, attached in shallow soundings, or specially adapted to a floating stence, are relatively unimportant. The authors suggest that the increased phytoplankton growth frequently observed where waters of different characteristics meet may often be due to the inoculation a sparse population, living under poor conditions, of favourable water which has lacked the spores necessary to take advantage of the good physico-chemical conditions.

With reference to the statement on page 160 that average conditions in a body of water comparable in size to the Mediterranean Sea do not change from year to year, it is felt that it would be difficult to constrate the absence of random and periodic fluctuations in the average temperature, salinity, oxygen content and contents of minor constituents, in existing data. Nor does it seem very probable that averages over longer periods, say ten years, could fail to reveal some significant changes in the range number of different species of organisms— apart from those due to overfishing. The decrease in phosphate concentration in the English Channel after 1880 and the decline of the herring fishery might be held as counter-evidence, and also the fluctuations in the northern fisheries, which are not entirely attributable to overfishing. These are, however, the fluctuations of a marginal region and rather a special case. There is another relevant statement on page 98, "for the earth as a whole, the total amount of heat that is received during one year from the sun and the limit of the atmosphere must exactly balance the total amount that in the same period is lost by radiation and radiation into space. Otherwise the temperature of the atmosphere and the oceans would change." It is not likely that the authors mean to exclude the possibility of small but significant fluctuations in the oceans.

The book gives a very practical account of the methods which have to be used in the absence of direct measurements to compute or estimate the speed and direction of ocean currents. It is worth noting that there is still no better means of judging accuracy obtainable from the practical application of Jerknes's theorem to the sea than the close agreement between Wust's calculations (1924) and Pillsbury's measurements (1889) for the Florida Current, or the measure of agreement between the move-

ments of Atlantic icebergs and the calculations of the Ice-Patrol. The same section gives the first publicity, outside enemy countries, to a new method of finding a suitable reference surface for the application of the theorem, first described by Defant in a German Atlantic Expedition report in 1941. It assumes that the surface of no motion lies in the depth interval within which the spacing of the isobaric surfaces remains more or less the same between adjoining stations. A certain amount of trial and error is necessary to find a continuous surface over a network of stations, but the method as used by Defant for the Atlantic Ocean gave results in good agreement with the best independent evidence. It has since been used in the Black Sea¹, and it will be tried extensively for other regions after the War.

From the section on tides and internal waves, it is clear that there can be large horizontal water-velocities at great depths. A mechanism exists which tends to sweep all fine material from peaks and ridges, to be deposited at greater depths. The absolute depth of the peak appears to be of no consequence, the sweeping is likely to be effective when the peak rises 500 metres above its surroundings, whether from 1,000 or 5,000 metres.

The longest chapter (157 pages) gives an excellent summary of the water masses and currents in all parts of the world. Arguing that it is rational to deal first with the simpler conditions, and gradually to enter upon the more complicated, the authors begin their survey with an account of the water circulation of the Southern Ocean, which is shown to be a very good field for oceanographical research.

Other long sections deal with the chemistry of sea water, waves and tides, marine sedimentation, organic production in the sea, the methods of making observations and collecting and the role of bacteria in the sea. The heat budgets of the oceans, differences in the balance between incoming and outgoing radiation and between evaporation and precipitation are closely considered, and throughout the book emphasis is given to the inter-relations between the oceans and the atmosphere. It is difficult to convey a true impression of the great wealth of information contained in the book. It is never likely to fail as a reference book, and it will be the starting point of many inquiries, foreseeing this, the authors have, when possible, referred to books containing comprehensive bibliographies rather than to original papers.

There are a few printer's errors, though none likely to cause serious misapprehension. It may be worth mentioning that the tonnage of the R R S *Discovery II*, quoted in Table 57, should be 1,200 tons displacement, not 2,100, and the constant at the foot of page 1,051 should be 0.02736, not 0.02763. It should also be noted that it is now common usage in English to refer to the periodical water movements accompanying the tides as tidal *streams*, keeping *currents* for the non-periodical movements due to other causes such as prevailing winds and density differences.

Of the thousand references at the ends of the chapters, half refer to American publications, a sixth to British and a sixth to German. The figures are an approximate measure of the relative efforts made in the three countries. They do not, however, reflect the importance which has been attached to oceanographical research in the Soviet Union and in Japan, probably because of the language difficulties. The Soviet Government is producing its own manual, which is likely to be the only rival to the American book for very many years. It will be a much larger

work when completed, and a glance at the first volume, although I have been unable to read it, suggests that it is more encyclopædic—mentioning almost everything that has been done

"The Oceans" will appeal to many seafarers, many ships would be glad to have a copy. There is no doubt that it will be very effective in promoting research, and increasing our knowledge of the oceans

G. E. R. DEACON

¹ "Die absolute Topographie des physikalischen Meeresniveaus und die Oberflächenströmungen des Schwarzen Meeres" By G. Neumann *Ann. Hydrog. und Mar. Meteorol.*, 70, ix (1942)

BIRDS OF THE SOUTH-WEST PACIFIC

Birds of the South-West Pacific

A Field Guide to the Birds of the Area between Samoa, New Caledonia and Micronesia. By Ernst Mayr. Pp. xx+316+3 plates (New York: The Macmillan Company, 1945). 3/75 dollars.

AFTER the American Forces commenced operations among the Pacific Islands, the American Museum of Natural History was inundated with requests for a book on the birds of the region. There was, however, no work on the whole area published, although many papers had been written on the birds of the different groups of islands. Fortunately, a member of the staff had already made a special study of the species found in the Pacific and neighbouring areas. This was Dr. Ernst Mayr, and no one was more competent to write the present volume, since, in addition to his systematic studies, he has spent several years in New Guinea, the Bismarck Archipelago and the Solomon Islands, and accordingly was familiar with many species in the field. The area covered by this volume comprises the groups of islands from Tonga in the south to the Mariana Islands in the north, and west as far as the Solomons.

In the introduction the author gives lucid hints on how to identify birds; he points out that though there may still be a few undetermined species in the mountains of the Solomons or in New Ireland, there remains much to learn of the life-histories and habits of nearly every bird.

The volume is divided into two parts: a general survey of the species, and more detailed lists of those found in the different groups of islands. In the first part, the birds are divided into groups, the sea-birds, shore-birds, and land- and freshwater-birds. Of the sea-birds, the terns are by far the most numerous and embrace thirteen different species, but only one gull, the Australian silver-billed gull, occurs in the area. On the other hand, the petrels, ranging in size from the wandering albatross to a Mother Carey's chicken, though much fewer in numbers, are represented by more than twice as many species. The other sea-birds are the frigate and tropic birds and the widely spread boobies. With the exception of the Australian stilt, all the shore-birds are migrants from the north. Several, including the common sandpiper, turnstone and sanderling, are familiar summer and winter visitors to the British Isles. The remaining section embraces a great diversity of types: cassowaries, grebes, ducks, hornbills, sun-birds, honey-eaters and others, as well as several introduced species, namely, the Indian myna, Malay turtle dove and red-browed waxbill.

The second part gives additional details of the land- and freshwater-birds inhabiting the different groups of islands, and here the observer will discover how little is known of the habits of many species. In some of the archipelagos certain birds, such as flycatchers, whistlers (*Pachycephala*), white-eyes and honey-eaters, tend to vary and divide up into races on the different islands. Dr. Mayr does not go into details on this point, but gives just sufficient particulars to recognize the races. This area is the headquarters of the brilliantly coloured fruit pigeons which combine such a wonderful variety of tints, and New Caledonia is the home of the flightless kagu which is now in danger of extermination since it falls an easy prey to prowling native dogs. The gems of the parrot-world, the tiny pygmy parrots, no more than 3½ in. long, are found in the Solomons, where they bore holes in the nests of tree-haunting terns where they deposit their eggs. They are reported to feed on their hosts or possibly fungi.

There is a map on the inside of the cover, the coloured plates and sixteen line drawings which will facilitate the naming of species.

Dr. Mayr is to be congratulated on the production of this small work at such short notice, and there is no doubt it will be welcomed by the troops in the Pacific.

ELEMENTARY ZOOLOGY

A Manual of Elementary Zoology

By Dr. L. A. Borradaile (Oxford Medical Publications). Eleventh edition. Pp. xiii+813 (London: New York and Toronto: Oxford University Press, 1945). 24s. net.

THE first edition of "Borradaile" appeared in 1912 and the second only in 1918. The start was no doubt due to the first World War, and it is interesting to compare the book's record in the second. At some time in 1939 there was a second impression of the ninth edition, then came the tenth edition in 1941, its second impression in 1943, and now the eleventh edition in 1945. One wonders how many students this very valuable book has helped through the bewilderment of their first contact with zoological facts and ideas, and how many professional zoologists it has extricated from class-room and other difficulties. The publishers do not announce the sales, but they must now be very many thousands.

The new edition continues the book's development. There is increased attention to problems of function, reducing the force of the criticism made by some that the book devotes to these subjects less attention than is due even in an elementary text. In addition there are some important changes in the chapters on embryology, where the development of *Amphioxus* is now based on Conklin's description. The account of gastrulation in the chick is the classical story of delamination, but more recent views are mentioned. The sections on genetics are somewhat expanded with some discussion of mutation and recombination and there are new diagrams of meiosis and crossing over. A new passage which should stir the interest of any intelligent student is that on the "History of the Vertebrata" in Chapter 22. Altogether, there are some fifty new figures.

The value of the book is proved by the number of its editions and reprintings; it is to be hoped that many more lie in the future.

P. D. F. MURRAY

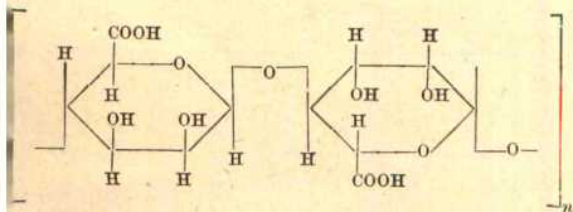
SEAWEED RAYON

By PROF. J. B. SPEAKMAN

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DRY seaweed contains 15–40 per cent of alginic acid¹, which is readily extracted with sodium carbonate solution². Sodium alginate was available in powder form before the War, but no serious attempt had been made to examine its possibilities as a raw material for the manufacture of rayon, despite the existence of abundant supplies of seaweed off the west coasts of Scotland and Ireland, and the ease with which filaments are obtained when a solution of sodium alginate is extruded into baths containing inorganic acid or a salt of a suitable polyvalent metal. Unfortunately, these favourable characteristics were overshadowed in the minds of early observers by the fact that the salts of alginic acid—or such of them as were examined—were found to be soluble in solutions of soap and soda. There seemed to be little purpose in devising satisfactory methods of spinning alginate rayons when the fabrics made therefrom would dissolve in the solutions commonly used in laundering textile materials. Furthermore, the prospect of producing alkali-resistant alginate rayons must have seemed remote in the absence of exact information about the constitution of alginic acid.

Alginic acid was recognized as a polymer of *D*-mannuronic acid in 1930³, but the precise mode of polymerization has since been the subject of much discussion. In the light of recent determinations of the equivalent weight⁴, the simple preparation of the di-acetyl derivative⁵, and an X-ray examination of well-oriented alginic acid filaments⁶, there can now be little doubt about the correctness of the constitution proposed by Lunde, Heen and Øy¹, supported by Hirst, Jones and Jones⁷ [see also p. 667], namely:



The molecular weight of the polymer is high, but varies with the mode of isolation: osmotic pressure determinations on a series of sodium alginates, dissolved in 0.2 *N* sodium chloride solution, gave values ranging from 48,000 to 185,000⁸. All such alginates should clearly be capable of successful use in the production of rayon, especially as the viscosity of relatively dilute solutions is great enough to permit successful spinning on the viscose system. In the early years of the War, therefore, when it seemed essential to make the fullest possible use in Britain of home-produced raw materials, the possibility of making rayon from seaweed was investigated.

Although the main purpose of the work was the production of alkali-resistant alginate rayon, the general problems involved in spinning satisfactory yarn from sodium alginate—satisfactory in appearance, feel and strength—were first investigated⁴ in two simple cases, namely, the spinning of calcium alginate and alginic acid yarns, both of which are soluble in sodium carbonate solution. The equipment used was similar to that employed in spinning viscose

rayon. A 5 per cent solution of sodium alginate was forced through a candle filter to a gear-wheel pump, which delivered the solution to a tantalum spinnerette immersed in a bath of acidified calcium chloride. In the preliminary experiments the spinnerette had twenty-one 0.1 mm. holes, and the resulting 21-filament yarn was drawn off by a glass revolving godet from which it passed through a traversing funnel into a Topham box revolving at 3,000 r.p.m. Here the yarn was collected in cake form. It was then washed, reeled into hanks and dried.

As produced in this way, the yarn was useless as a textile material: its handle was harsh and straw-like because the component filaments, which are highly swollen when first spun, adhere to one another during drying. The difficulty was overcome by extruding sodium alginate solution into a coagulating bath containing emulsified oil⁹, the filaments being thus coated with a film of oil which prevents adhesion. Although greatly improved, the handle and appearance of the resulting yarn were still unsatisfactory, owing to the irregular ribbon-like form of each filament. It was then found that the cross-section of the filaments became more and more nearly circular as the concentration of sodium alginate in the spinning solution was increased. Yarn of excellent handle and appearance was finally obtained by extruding a 7.5–8.0 per cent (w/w) solution of sodium alginate into a coagulating bath containing calcium chloride (1.0 *N*), hydrochloric acid (0.02 *N*) and 2.5 per cent by volume of olive oil emulsified with a neutral detergent such as 'Lissapol C' (I.C.I.). The tenacity of the yarn was, however, rather low, being no more than 1.23 gm./denier* at 64.8 per cent relative humidity, compared with values of about 1.3 and 1.8 gm./denier for cellulose acetate and viscose rayons, respectively. The weakness of the calcium alginate rayon was ultimately traced to two causes: degradation by acid carried over from the coagulating bath during the time the cake is being spun, and mechanical damage to the freshly spun, swollen filaments when the yarn is reeled into hank form for drying. The first difficulty was overcome by washing the yarn as it traversed the godet on its way to the Topham box; and the second by leading the yarn from the cake through running water, then through a dryer, and winding directly on to bobbins. With these refinements, no difficulty was encountered in producing yarns with a tenacity of 1.8–2.1 gm./denier at 64.8 per cent relative humidity.

Attention was next turned to alginic acid rayon, which is more difficult to spin because, in the absence of metal-containing cross-linkages, the filaments are weak and highly swollen. To prevent filament adhesion during drying, it was found necessary to emulsify the oil in the coagulating bath with a cation-active agent, such as 'Fixanol' (I.C.I.), which is adsorbed by the filaments. Good results were obtained by extruding sodium alginate solution into a coagulating bath containing sulphuric acid (1.0 *N*) saturated with sodium sulphate and 2.5 per cent by volume of olive oil emulsified with 1 per cent (w/v) of 'Fixanol'.

It is, however, unlikely that alginic acid yarn will ever be produced on the large scale because of the rapidity with which it undergoes degradation during storage. Even when kept in the dark at 65 per cent relative humidity and 22.2° C., the tenacity of a well-washed alginic acid yarn fell from 1.06 gm./denier after 28 days to 0.36 gm./denier after 480 days¹⁰.

* The denier of a yarn is the weight in grams of 9,000 metres.



Fig. 1.

Well-washed calcium alginate yarn, on the other hand, can be stored for periods up to at least thirty weeks without significant loss of strength, and can be converted into alginic acid yarn, whenever necessary, by mere washing with cold, dilute hydrochloric acid.

As soon as satisfactory methods of spinning alginate rayons had been devised, the possibility of producing alkali-resistant rayons was investigated. It seemed likely that success might be achieved by cross-linking alginic acid with metals of high co-ordinating power, such as chromium¹¹ and beryllium¹², instead of with calcium. When, however, sodium alginate solution was extruded into baths containing chrome alum and beryllium sulphate, the resulting yarns were harsh, wiry and brittle, despite the presence of emulsified oil and cation-active agents in the coagulating baths⁴. Direct spinning of chromium and beryllium alginate rayons was found to be impossible, but when calcium alginate rayon was treated with a 2 per cent solution of one-third basic chromium acetate¹³ at 25° C., calcium was displaced by chromium. The extent of displacement increased with increasing time of treatment, but yarn containing as little as 1.29 per cent chromium, while retaining 9.04 per cent calcium, was undissolved after immersion for twenty-four hours in a solution of soap and soda at room temperature. Similarly, a yarn containing 2.89 per cent beryllium and 5.20 per cent calcium, prepared by treating calcium alginate rayon with a 2 per cent solution of basic beryllium acetate⁴ at room temperature, was found to be alkali-resistant. In both cases, the stability of the yarns appears to be due to co-ordination of the metal—chromium or beryllium—with the hydroxyl groups of alginic acid.

Still better yarns were obtained—better in being free from calcium—by treating alginic acid yarn, derived from calcium alginate yarn, with the basic acetates of the metals. Prepared in this way, both chromium and beryllium alginate rayons suffer less than 5 per cent loss in tenacity on treatment with a solution of soap and soda for thirty minutes at 25° C. or 40° C., and the beryllium alginate rayon, which is more useful in being uncoloured, has a tenacity of more than 2.0 gm./denier.

Alkali-resistant rayon can also be obtained by cross-linking alginic acid yarn with formaldehyde¹⁴ instead of co-ordinating metals. Cross-linking is

brought about by impregnating the yarn with a solution of ammonium chloride and formaldehyde at pH 3, and then drying at 95° C. As the carboxy groups of the treated filaments are free, the yarn though undissolved, is swollen by alkalis, but swelling can be restricted by further treatment with the basic acetates of chromium and beryllium.

Ultimately, therefore, the basis of all the alkali-resistant seaweed rayons is calcium alginate rayon which is cheap and easily spun, and possesses satisfactory elastic properties for weaving and knitting. For these reasons it seems likely that calcium alginate rayon will form the stock material for all purposes for conversion into woven and knitted fabrics, which can be made alkali-resistant in finishing, as well as for special uses in which advantage is taken of its solubility in alkalis. These special uses¹⁵, which are now so numerous as to make the alkali-soluble rayon as important as the alkali-resistant varieties, were developed in the belief that a defect can always be turned to advantage. Two illustrations will perhaps serve to indicate the power which has thus been placed in the hands of the textile designer. When a fabric is woven from yarn prepared by twisting together cotton and calcium alginate yarns in such a way as exactly to remove the twist from the cotton yarn, subsequent scouring leaves a cotton fabric composed of yarns entirely without twist; fabrics of this type have already found a number of important practical applications. Secondly, if a fabric is woven from yarns prepared by twisting together mohair and calcium alginate yarns in such a way as to persuade the mohair to wrap around the alginate, the extra length of mohair is released to form loops on the surface of the cloth, as shown in Fig. 1, when the fabric is scoured in a solution of soap and soda. The 'disappearing fibre' technique has, in fact, simplified the methods of manufacture of a large number of fabrics, besides indicating how a number of new effects may be obtained.

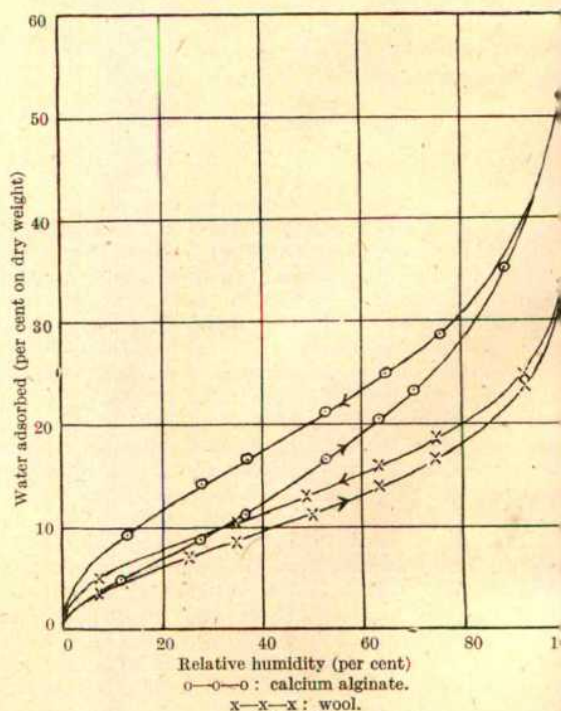


Fig. 2.

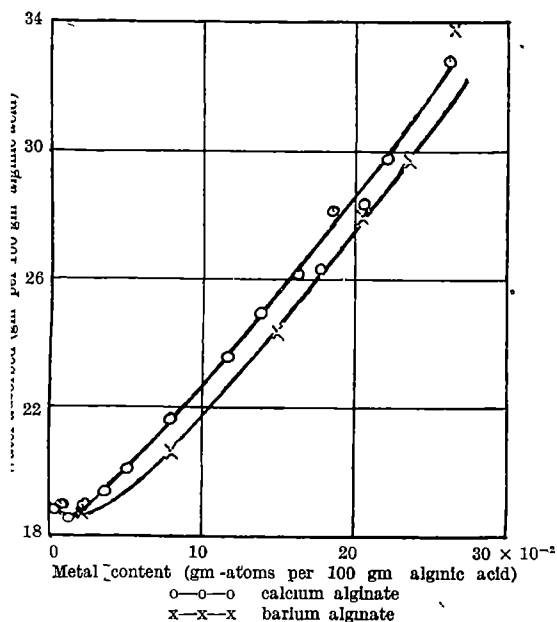


Fig. 3.

In view of the importance of calcium alginate rayon, its properties have been examined in greater detail than those of other alginates. The yarn as a relatively high tenacity, varying from 1.8 to 1 gm/denier, with an extension at break of about 10 per cent at 64.8 per cent relative humidity because of its high metal content (about 10.4 per cent), calcium alginate has the rather high density of 7.8 when dry, but the presence of the metal has the great advantage of making the material totally non-flammable, a property which is shared by other metal alginates. All the alginates have a high water-absorption capacity, higher than that of other textile fibres, as shown in Fig. 2, where the adsorption and desorption isotherms of calcium alginate and wool at 5° C are reproduced. In general, the water-adsorption capacity increases with increasing metal content, closely related results being given by alginates

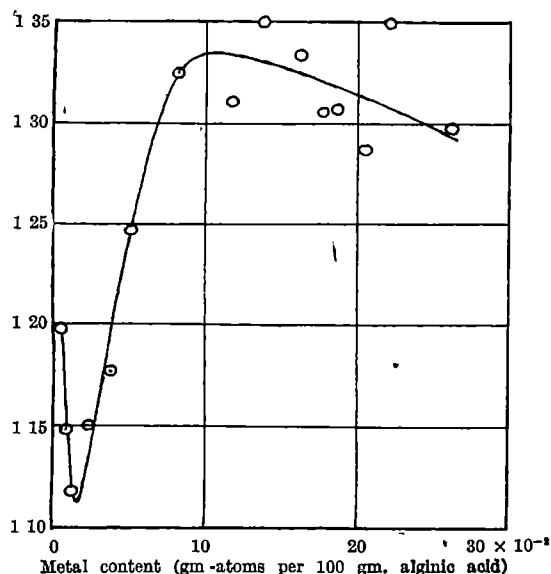


Fig. 4

derived from metals in the same group of the Periodic Table. This interesting observation is illustrated by the curves of Fig. 3, where the amounts of water adsorbed by a series of calcium and barium alginates at 64.8 per cent relative humidity and 22.2° C are shown as a function of the metal content. As would be expected, too, the breaking load of calcium alginate yarns increases with increasing metal content, on account of the increasing number of cross-linkages between the chain molecules, but since the density of the yarn also increases, there is an optimum metal content for maximum tenacity (gm/denier) as shown in Fig. 4.

Alginate rayons have a marked affinity for basic dyes. In addition, they can be dyed with selected direct dyes and, when the yarns contain chromium or beryllium, with mordant dyes. There is, therefore, good reason to believe that the seaweed rayons will find an important place in the textile industry of the future.

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² Stanford, *J. Soc. Chem. Ind.*, 3, 297 (1884), 4, 518 (1885), 5, 218 (1886).

³ Nelson and Cretcher, *J. Amer. Chem. Soc.*, 52, 2130 (1930).

⁴ Speakman and Chamberlain, *J. Soc. Dyers and Colour.*, 60, 264 (1944).

⁵ Cunningham, Chamberlain and Speakman, *Brit. Pat. Applic. No.* 9118 (1942).

⁶ Astbury, see *J. Soc. Dyers and Colour.*, 60, 265 (1944).

⁷ Hirst, Jones and Jones, *J. Chem. Soc.*, 1880 (1939).

⁸ Rose, Ph.D. Thesis, University of London, 1937.

⁹ Speakman, *Brit. Pat.* 541,848 (1941).

¹⁰ Chamberlain, Johnson and Speakman, *J. Soc. Dyers and Colour.*, 61, 13 (1945).

¹¹ Speakman, *Brit. Pat.* 541,847 (1941).

¹² Speakman, *Brit. Pat.* 545,872 (1942).

¹³ Race, Rowe and Speakman, *J. Soc. Dyers and Colour.*, 55, 69 (1939).

¹⁴ Speakman and Chamberlain, *Brit. Pat. Applic. No.* 432 (1942).

¹⁵ Johnson and Speakman, *Brit. Pat.* 550,525 (1943).

THE CHANGE FROM TRICHROMATIC TO DICHROMATIC VISION IN THE HUMAN RETINA

By PROF. H. HARTRIDGE, F.R.S.

MANY years ago I noticed the confusion of yellow with white, and blue with black when test objects of small size are under critical examination¹. I thought, incorrectly, that this confusion was due to the chromatic aberration of the eye. Some years previously, König had, unknown to me, given the true explanation of the phenomenon, namely, that for objects of small size, examined by the fovea centralis, trichromatic vision is replaced by dichromatic vision². He thought that this change was strictly limited to the fovea centralis. Recently Willmer has come to the same conclusion³. Both König and Willmer are mistaken, however, for in a recent communication in *Nature*, I have produced evidence that the change occurs not only at the fovea centralis but practically all over the useful retina⁴. Further evidence on this point has now been obtained, together with many other facts, concerning the appearance of the colours of very small objects.

1. *Effect of angle of view.* Before beginning this section it is necessary to point out the difference between angle of view and visual angle. By the former is meant the angle between the fixation axis and the line joining the centre of the test object with the eye. By the latter is meant the angle between

the lines joining the edges of the test object with the eye. Thus when the centre of the image of the test object falls on the fovea centralis, the angle of view is zero. When, however, the observer directs his gaze more and more to one side of the test object, the angle of view increases in value, while the visual angle stays constant.

During the tests on the effect of angle of view, a yellow test object, 6 mm square, was viewed on a black ground in daylight. Four small blue-green fixation marks were placed on the background with their centres 4, 8, 12 and 16 cm below the centre of the test object. Each observer determined (1) the distance at which the test object was definitely yellow, (2) the distance at which it appeared to be white, (3) the distance at which the transition from yellow to white occurred. The observer fixated the test object or one of the blue-green fixation marks as might be required. The results are shown in the following table.

		Fixation at				
		0	4	8	12	16 cm
H H		6.5 metres	8.5 metres	12.0 metres	23.0 metres	12.0 metres
1	11.0	"	11.5	"	19.5	"
2	11.0	"	11.5	"	27.0	"
3	9.0	"	9.5	"	24.5	"
J L d'S						
1	18.5	"	22.0	"	27.0	"
2	24.0	"	28.5	"	34.0	"
3	22.5	"	25.0	"	31.0	"
E. C T						
1	16.0	"	13.0	"	11.0	"
2	21.5	"	21.0	"	19.0	"
3	18.5	"	18.0	"	16.0	"
G N J						
1	5.5	"	8.5	"	7.5	"
2	10.5	"	12.0	"	12.0	"
3	8.0	"	10.0	"	13.0	"

The above table brings out two points: that the transition from yellow to white occurs at peripheral parts of the retina just as it does at central parts, and that considerable variations in detail occur between different observers.

I have assumed that the transition from yellow to white indicates that trichromatic vision has been replaced by dichromatic vision. Evidence on this point will be found in Section 13 of this article. On the assumption that this evidence is acceptable, the following statement can be made. For test objects of average size the colour vision of normal persons is approximately trichromatic, while for test objects of sufficiently small size, colour vision is nearly dichromatic (see Section 14). The transition occurs at a given distance from the eye for a particular size of test object which depends on several factors. Two of these are shown in this section to be the observer, and the angle of view.

2 *Importance of area of test object* The distance between object and observer at which the transition from yellow to white takes place might depend, for example, on the area of retina which is being stimulated, or on the quantity of light which is falling on the retina, or on the length of contour of the test object. Various tests were carried out on these lines, and area was found to be an important factor. In the following table the distances are recorded at which two yellow test objects of the same area but of different shape were found to become white.

	Square test object	Oblong test object
Length	12 mm.	6 mm
Width	12 "	24 "
Length of contour	48 "	60 "
E. C. T	28.5 metres	26.5 metres
J L d'S	28.0 "	25.5 "
E. B C	26.0 "	27.0 "
H H	16.0 "	18.0 "

Observer H H knew that the two areas were equal. Observers E C T, J L d'S and E B C were unaware of the nature of the experiment, and their observations were therefore free from bias. In the case of each one of them the conclusion is that neither shape nor length of contour has any obvious effect on the distance at which yellow becomes white.

This conclusion was deemed to be of sufficient importance for a further test to be justified. On test object consisted as before of a yellow square on a black ground. The other consisted of a yellow square of precisely the same dimensions as the first and from which a U-shaped piece had been cut leaving a π -shaped piece behind. These two pieces were placed near one another, but not touching, on a black ground and were together used as the test object.

First the uncut square was presented to the observer and then the cut one. The results obtained were as follows.

	Uncut square test object	Cut square test object
Area	144 sq mm	144 sq mm
Length of contour	48 mm	128 mm
E. B C	20.5 metres	19.5 metres
J L d'S	25.7 "	27.7 "
E C T	28.7 "	29.3 "

In this case also, the differences in distance are small and within the probable experimental error, so that in spite of the great difference in the shape and in the length of contour of the two test objects they change colour at the same distance from the eye.

These tests show that neither shape nor length of contour are important factors in determining the distance at which the change from yellow to white takes place.

Further evidence on this point will be found in Section 10.

That alteration in size greatly affects the distance in metres at which the transition from yellow to white takes place is shown in the following table.

	J L d'S	G W J	H. H	E C T	J E T	Mean
Size						
6 mm	6.1	8.0	9.3	10.7	13.5	9.9
12 "	11.8	10.1	17.7	17.7	18.8	15.2
24 "	19.3	20.3	30.0	25.3	23.3	23.6

All these test objects were yellow squares on black ground, one had 6-mm sides, whereas the other two had sides of 12 mm and 24 mm respectively. It would be expected that a doubling of the side of the square would double the distance at which the transition took place. This was found not to be the case for any one of the observers. The cause of the discrepancy is probably that, as the observer increased his distance from the test object, alteration took place in the images falling on peripheral parts of the retina.

3 *Effect of eye movements* König noticed the difficulty of holding the test object constantly on the fovea centralis². The slightest movement led to the re-establishment of normal trichromatic vision. This was this observation that led him to suppose that area of dichromatic vision to be very small.

I have also noticed this difficulty, but I have found that it occurs not only in the fovea centralis, but also in parts of the retina considerably peripheral to it. Thus when the image of a yellow test object falls on one side of the fovea centralis, and exact fixation is performed, the yellow is replaced by white and remains white during exact fixation. On the slightest movement performed by the observer's eye, however, the true yellow colour of the test object is momentary.

rily disclosed to view. The explanation of this phenomenon is that the change from trichromatic to dichromatic vision occurs locally, being limited to the area on which the image of the test object falls, but if the test object be moved, or the eye axis be altered, a fresh area of retina is involved and for a moment reacts in a normal trichromatic manner. Then it too changes, and becomes dichromatic.

4 *Effect of simultaneous presentation.* From past experience it was expected that simultaneous contrast would affect the apparent colour of the test object. Thus if an observer stood at a distance from a yellow test object on a black ground so that the former was at the transition point between yellow and white, then it would be expected that the close proximity of a white area would, owing to contrast, cause the test object to appear yellow, and that similarly the close proximity of a yellow area would cause the test object to appear white. Tests showed that precisely the opposite took place, for when the white area was placed in position the test object appeared white, and when the yellow area was placed in position the test object appeared yellow.

The cause of this phenomenon probably is that the test object, and the coloured area that has been placed near it, form together a single stimulus to the retina, and their combined areas are taken into account when determining whether or not the change from trichromatic vision to dichromatic vision shall occur (see Section 10). Thus a single yellow test object may be viewed at such a distance that it has the appearance of being white, but, on placing a second yellow test object close to it, it immediatelyverts to yellow. One test object alone is so small that dichromatic vision is replaced by dichromatic vision. Then, however, there are two such objects in the visual field, their combined areas may be too large for dichromatic vision to be possible, and in consequence there is a return to trichromatic vision.

5 *Spatial effect.* It has been shown in the previous section that the close proximity of a yellow area biases the test object towards yellowness, and that similarly a white area biases it towards whiteness. In this section the effect of distance between the test object and the coloured 'biasing' area will be dealt with. The test object was a yellow square with 12 mm sides. The 'biasing' area was a yellow rectangle 10 mm high and 25 mm wide. This was placed at various distances from, and to the left-hand side of, the test object. On the other side of the test object is a white 'comparison' area 100 mm high and 25 mm wide. This was placed at a constant distance of 20 cm. from, and to the right-hand side of, the test object. The results obtained were as follows:

Distance between test object and 'biasing' area	Distance for test object to appear white
Infinity	8.8 metres
20 cm	12.5 "
10 "	18.5 "
5 "	23.0 "
0.5 "	38.0 "

It will be seen that as the distance between the 'biasing' area and the test object is reduced, the greater the distance becomes at which the test object appears white.

6 *Overlap.* On numerous occasions it has been noticed that the change from trichromatic to dichromatic vision does not occur sharply, nor does it always occur when the test object is at the same distance from the observer. Sometimes the phenomenon of overlap is observed. The change from low to white may occur at a considerably greater

distance between test object and observer than the reverse change from white to yellow. Overlap is more likely to be observed when very careful fixation is being preserved, for the slightest eye movement reduces it considerably. It is as if the mechanism causing the change in vision suffered from backlash, and that small eye movements have the effect of reducing this.

7 *Effect of brightness of illumination of the test object.* Unfortunately, it has not been possible owing to war conditions to perform any precise measurements on the effect of illumination on the change from trichromatic to dichromatic vision. On a number of occasions, however, tests have been made to see if the intensity of illumination of the test object plays an important part. The reason for making these tests is that since the change-over depends on the area of the test object, and not on its shape (see Section 2), it might be that the total amount of light reaching the retina is really the determining factor; in other words, the product of area and illumination, allowance being made for any variations in the diameter of the pupil. Illuminations of 1-3,000 ft. candles approximately have been tested, using an artificial pupil of 1.5 mm. There is no doubt that light intensity plays some part as the following values show:

A yellow test object 6 mm square changed to white at following distances			
1 ft. c	12 ft. c	100 ft. c	3000 ft. c
1.7 metres	3 metres	8 metres	18 metres

Illumination does not play the important part, however, which it would do if total light reaching the retina was the criterion. For change in illumination of 1 to 3,000 ft. c. would then be accompanied by a change of distance in the ratio of 1 to 55. Change in the degree of light adaptation may well have taken place in the above experiments. The possible effect of this will now be explored.

8 *Effect of adaptation.* The effect of adaptation on the distance at which a yellow test object becomes white has been tested by taking two adaptation levels: light adaptation by gazing for 1 min. at the sky, and dark adaptation by excluding light from the eyes for 5 min. It was realized that neither full light adaptation nor full dark adaptation would be obtained in such short times. The object of this experiment was to ascertain if adaptation produced a noticeable change in the distance at which the test object changed colour.

The result obtained was far from satisfactory. On some occasions light adaptation seemed to increase the distance, whereas on others it seemed to produce no effect or even a slight decrease. On the whole, some increase of distance seems to be produced, but the effect is not a marked one. It might account in part, however, for the increase in distance with illumination noted in the previous section.

9 *Effect of depth of tint of test object.* If several yellow test objects of the same shape and size, but of different depth of tint, be tested as before, it will be found that very obvious variations occur in the distances from the observer at which they become a neutral tint: white in the case of the paler shades of yellow, but grey in the case of the darker shades. The following example is typical of the results obtained:

Colour of test object	Distance in metres
Pale lemon yellow	12.5
Daffodil yellow	18.0
Chrome yellow	27.0

As might be expected, a deep tint requires a greater distance than a pale one, since in the latter case the colour is already diluted with white light

10. *Effect of the shape of the test object* Two experiments have been described in Section 2 in support of the statement that it is area and not shape which determines the distance at which a yellow test object changes to white. It is, however, only necessary to take an extreme case to see that this cannot always be the case. Suppose, for example, that the whole or an important part of the image fell on the blind spot, then that part, at all events, would contribute little if at all to the stimulation of the retina. It is possible also that parts of the test object falling outside the fovea will have a significantly different effect from those parts which fall inside it. To test this possibility two test objects were compared. One as before consisted of a yellow square with 12 mm sides, the other consisted of a similar square which had been divided into nine squares each with 4 mm sides. One of these squares, which was used as the fixation point, was mounted on the centre of a black ground, the others were mounted in a ring of 10 cm. radius around the central one to form a star. The following distances were obtained:

	Square test object (area, 144 sq mm)	Star test object (area, 144 sq mm)
G N J	yellow at 8.5	5.5
	white at 12.2	12.0
	mean 10.4	8.8
H H	yellow at 11.6	6.6
	white at 15.0	11.5
	mean 13.3	9.0
J L. d'S.	yellow at 17.7	15.0
	white at 23.7	21.7
	mean 20.7	18.4
E C. T.	yellow at 7.0	7.5
	white at 16.0	15.0
	mean 11.5	11.3

All four observers found that a somewhat greater distance was required for the square than for the star. In the case of any one observer, the differences are probably within the experimental error; but since all four observers found the differences in the same direction, I think they are significant. It is not, however, the magnitude of these differences which I wish to emphasize, but on the contrary their smallness. They indicate the apparently extraordinary facility with which the retina integrates the various parts of a pattern so as to ascertain the total area.

Until further experiments have been performed the following provisional statement may be made. provided that no part of a pattern falls on the blind spot or on some other defective area of the retina, and provided that the parts of a pattern are not too widely separated, the retina integrates the various parts of the pattern so as to arrive at the total area.

11. *Effect of pupil diameter* Artificial pupils were used to reduce the aperture of the eye to the required size, and the effect on the distances at which a yellow test object on a black ground became white were determined.

Pupil diameter	Illumination rates	Distance at which yellow becomes white
5.7 mm.	32.5	15.0 metres
4.8 "	23.0	10.5 "
4.0 "	16.0	9.1 "
3.2 "	10.2	8.6 "
2.4 "	5.8	7.5 "
1.6 "	2.6	6.2 "
1.0 "	1.0	5.0 "

As the aperture of the eye is reduced in size, the distance from the observer to the test object becomes less. Now a reduction in aperture is accompanied by

a reduction in the light intensity reaching the retina and, as seen in Section 7, the latter is accompanied by a decrease in the distance at which yellow becomes white. In Section 7 it was found that an increase in illumination from 1 ft c to 100 ft c required an increase in distance from 1.7 to 8 metres, that is 4.7 times. This increase corresponds reasonably well with that given by the change in pupil diameter Δ , suggested in Section 8, the effect of change in illumination may be due to a change in retinal adaptation. It is possible that the effect of change of pupil diameter here recorded may have a similar cause.

12. *Effect of colour of the background* It seems likely that a yellow test object on a blue ground would tend to retain its colour more readily than on a black ground, because the blue ground would enhance the yellow colour by simultaneous contrast. Experiments showed that the exact opposite is the case, as the following results show.

Colour of background	Distance at which yellow becomes white
Black	17.4 metres
Blue	9.3 "

The explanation given previously appears to be correct, namely, that the chromatic aberration of the eye causes the blue ground to overlay the yellow test object and therefore to reduce its yellowness since blue and yellow are complementary in colour to one another⁷. The following observations support this conclusion. The effect of pupil diameter on the distance at which a yellow test object on a blue ground becomes white is shown in the table below.

Pupil diameter	Distance at which yellow becomes white	
	on blue ground	on black ground
5.7 mm	8.3 metres	15.0 metres
4.8 "	8.5 "	10.5 "
4.0 "	8.6 "	9.1 "
3.2 "	8.0 "	8.6 "
2.8 "	7.3 "	—
2.4 "	6.0 "	7.5 "
2.0 "	6.5 "	—
1.6 "	5.6 "	6.2 "
1.3 "	5.2 "	—
1.0 "	5.0 "	5.0 "

If the values in the second column be compared with those given in the previous section, which are repeated in the third column above, it will be seen that with large pupils the substitution of the blue ground for the black one greatly reduces the distance at which yellow becomes white, but that as the pupil is reduced in size, the difference gets less and less until at 1 mm aperture the difference disappears entirely. The explanation is as follows. With large pupils the effect of chromatic aberration is considerable, and since blue rays come to a different focus from yellow rays, the latter are mixed with blue former to produce white, when a yellow test object lies on a blue ground. This is not the case, however, when a yellow test object lies on a black one. Consequently, the latter requires a greater distance for yellow to become white than does the former. With small pupils, on the contrary, the effect of chromatic aberration is small, so that scarcely any mixing of test object with background takes place. In consequence, the substitution of a blue ground for black one has scarcely any effect on the distance at which the yellow test object becomes white.

13. *Effect of the colour of the test object* In previous sections the experiments described have been limited to yellow test objects, because it was considered better to concentrate on one colour rather

han⁶ to describe the use of one colour for one test and another colour for a different test. The main conclusions reached with yellow have, however, been tested with other colours, namely, green, blue, purple and crimson. Green on a black ground both at the fovea and the periphery becomes blue-green, and so does blue. Purple becomes reddish-brown, and crimson becomes orange. In no case has an observation been made which would lead to the conclusion that the change, either at the fovea centralis or at the more peripheral parts of the retina, is not one of dichromatism of the type described previously. Therefore, so far as is known at present, all the experiments described using a yellow test object could be done equally well, and with a similar result, with a test object of any of the other colours mentioned above.

14 *Nature of the dichromatism* When studying the changes in colour which take place when very small test objects are looked at, three unexpected observations were made.

(1) The short-wave end of the spectrum was expected to be blue-green, precisely complementary to red. It seemed, however, to be too blue for this to be the case.

(2) Instead of orange appearing to be red diluted with white, as would be the case if true dichromatic vision was present in the retina, it was found that orange retained its natural colour.

(3) It was observed that crimson, which was expected to become some shade of red mixed with white, actually became orange.

All the above anomalies obviously require explaining. In the first place, an explanation was sought on Young's theory of trichromatic vision without a satisfactory result, so that an alternative explanation was sought for. This was obtained on the basis of Granit's results with mammalian retinas using micro electrodes⁵.

Granit, in a private communication, has informed me that he has obtained evidence of seven varieties of modulator in the mammalian retina: two red ones at 600 λ (common) and at 580 λ (less common), two green ones at 540 λ , at 520 λ , and at 500 λ , and two blue ones at 460 λ and at 330 λ .

Now if the dichromatism left unchanged the two red receptors at 600 λ and 580 λ , but converted all the remainder except the blue ones into a single sensation, then a modified form of trichromatic vision could result, namely: red due to the sense organ for 600 λ , orange due to the sense organ for 580 λ , and greenish-blue due to the connecting together of the sense organs for 540 λ , 520 λ and 500 λ with the green and blue visual centres (see Section 15).

Such vision would, I think, account for (a) the reception of orange as being different from red mixed with white, (b) the modification of crimson to orange, and lastly (c) the fact that the blue-green sensation has a strong predominance of blue.

15 *Hypotheses of the change from tri- to dichromatic vision*

Hypothesis 1. The change resembles simultaneous contrast in affecting the margins of the test object. Thus, suppose a yellow test object on a black ground appear to the eye to have a narrow white margin, then as the test object is reduced in size the white margin should encroach more and more on the yellow central area until the whole of the test object has become white. This hypothesis was tested in two ways. (a) By taking two yellow test objects of the same area but very different shape, one square and

one oblong. If this hypothesis were true, the square test object would require a much greater distance than the oblong one in order to become white. Experiments showed, however, that the two distances were nearly the same (see Section 2). (b) By taking two oblong test objects of the same shape and size, one having yellow edges and white centre, the other having white edges and a yellow centre, both on black backgrounds, the yellow areas being equal. If this hypothesis were true, the former ought to appear white at a shorter distance than the latter. Experiment showed the two distances to be nearly the same. This hypothesis must therefore be abandoned.

Hypothesis 2. That it is due to stray light entering the eye from surrounding objects. This hypothesis was tested by causing the observer to look down a narrow blackened tube at the yellow test object, the distance at which the transition of yellow to white occurred being noted. This distance was found to be the same as that obtained without the tube, so that stray light does not appear to be a contributory cause.

Other hypotheses similarly tested were (3) that it is due to the chromatic aberration of the eye, (4) that it is due to haze between the test object and the observer. As none of these hypotheses explained the phenomenon, a physiological explanation must be looked for, such as the cancellation of a sensation as in protanopia (red blindness), or the linking of two sensations as in deutanopia (green blindness)⁸.

16 *Cancellation and linking* Cancellation of the red sensation would cause white to appear blue-green, cancellation of the green sensation would similarly cause white to appear purple, while cancellation of the blue sensation would cause white to appear yellow⁴. Since white does not change in any of these ways, cancellation does not appear to account for the phenomena which are observed. Linking of red and green would cause one end of the spectrum to appear yellow and the other end blue. Linking of red and blue would cause both ends of the spectrum to appear purple, and the middle region to appear green. Linking of green and blue would cause one end of the spectrum to appear red and the other end blue-green. Of the three types of linking it is obvious that the last most closely fits the observed facts.

In one important respect, however, this plan requires modification, namely, with regard to the blue and violet parts of the spectrum. If there were simple linking and nothing more, then the blue and violet parts of the spectrum would be modified in colour to blue-green, but would retain their normal brightness when seen at small visual angles. Such, however, is not found to be the case, for there is always a considerable reduction of brightness in the case of both colours. When a very bright spectrum, such as that of a carbon arc, is examined in such a way that it subtends a very small angle at the eye, its short-wave end is found to terminate at the same wave-length as it does when it subtends a large angle at the eye. When, however, a spectrum of average brightness is examined in the same manner, then there is seen to be considerable shortening of the short-wave end when it subtends a small angle at the eye, but little or no shortening when it subtends a large angle. This fits in with the observation that blue and violet test objects lit by ordinary daylight appear dark grey or black when they subtend small angles at the eye. If now their intensities be greatly increased, then both are seen to be blue-green in colour. A hypothesis which fits all the above facts is

that for test objects subtending small visual angles the brain centres for green and blue are linked together and are connected with the sense organs responding to green rays, while at the same time the sense organs responding to blue rays are temporarily put out of action.

17 *Nervous level of the mechanism*. A question which naturally presents itself concerns the position of this linking and cancelling mechanism. Is it situated in the retina, or in some part of the brain?

The following experiment points to a definite location. A grey test object is placed on a bright blue background in order to produce a yellow coloration of the former by simultaneous contrast. If now the distance between test object and observer be increased, it is found that the yellow coloration diminishes and at a certain distance disappears altogether, being replaced by white. This experiment shows that a subjective yellow behaves in the same way as a real yellow does with decrease in visual angle, and the mechanism producing the change must therefore operate on both. This mechanism must therefore be situated at a higher nervous level than the one which is responsible for simultaneous contrast. Now in Burch's celebrated experiment⁶ in which, using a stereoscope, a grey test object on a blue ground was presented to one eye while another grey test object on a red ground was presented to the other, the two coloured grounds fused to form a single purple ground, but the grey test objects retained their individuality, that on the blue ground remaining yellow, that on the red ground remaining blue-green. This experiment showed that simultaneous contrast occurs at a nervous level below that at which binocular fusion occurs.

Now as we have said above, the mechanism for converting trichromatic to dichromatic vision appears to be situated at a higher nervous level than that responsible for simultaneous contrast. It might therefore be either between the levels for simultaneous contrast and binocular fusion or above both levels. Evidence has been obtained and will be described elsewhere that the former is probably the case.

I would like to express my thanks to those who have acted as observers for me.

¹ Hartbridge, H., *J. Physiol.*, 52, 175 (1918).

² König, A., *Acad. Wiss. Berlin*, 577 (June 1894).

³ Willmer, E. N., *Nature*, 153, 774 (1944).

⁴ Hartbridge, H., *Nature*, 155, 391 (1945).

⁵ Granit, B., *Nature*, 151, 11 (1943).

⁶ Burch, G. J., *J. Physiol.*, 25, xvii (1900).

⁷ Hartbridge, H., *Nature*, 153, 775 (1944).

⁸ Pitt, F. H. G., *Proc. Roy. Soc. B*, 132, 101 (1944).

OBITUARIES

Sir Ambrose Fleming, F.R.S.

JOHN AMBROSE FLEMING was born at Lancaster on November 29, 1849, and died at Sidmouth on April 18. He was the eldest son of the Rev James Fleming. His mother was a daughter of John Bazley White, an engineer who pioneered the manufacture of Portland cement in Kent. About 1856 the Fleming family moved to London and in 1863 Fleming entered University College School. He has recorded that he was always at the bottom of the Latin classes though quick at mechanics and science. Evidently in these respects he was nearer his maternal grandfather than his father.

In 1866 Fleming entered University College, but he had to leave before graduating. For a year he worked in a shipwright's drawing office and then for two years as a stockbroker's clerk. In his leisure he prepared for the B.Sc. degree. In 1871 he became science master at Rossall School, and in two years saved enough to allow him to enter the Royal College of Chemistry, South Kensington. There, under Franklin, he began his research career, and in 1874 read his first paper, on a form of voltaic cell, at the first meeting of the Physical Society of London. His funds being spent, he went as science master to Cheltenham College and in two years saved enough to enter St John's College, Cambridge, at the age of twenty-eight, with the aid of an open exhibitor.

He attended Maxwell's lectures in 1878 and 1879, the last two years of Maxwell's life, and worked in the Cavendish Laboratory on electrical resistance standards. He obtained a first class in the Natural Sciences Tripos in 1880 and became lecturer in applied mechanics in the new University engineering laboratories. He was made a fellow of St John's in 1882. After a short time at Nottingham, where he held the professorship of physics, he returned to London to start a consulting practice in 1882. In 1884 he was invited to become the first professor of electrical engineering at University College, and he occupied this chair for forty-one years, the inaugural period of the electrical age.

Fleming began his consulting career at the age of thirty-three by becoming adviser to the Edison Telephone Company and continued with it after it was combined with the Bell Telephone interest. Later, when the Edison Electric Light Co. was formed, he became its adviser on the equipping of generating stations and distribution networks. After the carbon filament lamp was invented, he became the adviser of the Edison and Swan combination, particularly of the photometry of lamps. Later he advised a number of English towns on the adoption of electric light. He was also consulted by the London Electric Supply Corporation when it was installing the Ferranti alternating current system in London. In 1899 he became consultant to Marconi's Wireless Telegraph Company and took part in the design of the Polden Station, the first large wireless station in England. In the course of this work he devised new methods and new instruments for the measurement of high frequency current, and he was the first to demonstrate that the thermionic rectifier could operate at radio frequencies. Thus during many years and in many directions he assisted in the adaptation of revolutionary electrical industries to English conditions, and aided the technical development of many fundamental electrical inventions. As fast as he gathered experience in these new technical developments, he passed it on in lectures to his students and to public audiences. He also read widely the expanding electrical technology and lucidly expressed its essence in his lectures. Some of his lecture courses were published as text-books. Among such books one recalls with gratitude "The Alternating Current Transformer", "The Principles of Electric Wireless Telegraphy", "The Propagation of Electric Current in Telephone and Telegraph Conductors", "Electric Lamps and Electric Lighting".

In the midst of all these applications of science to engineering, Fleming found time and energy for a number of physical investigations—for example, the measurement of the electrical and magnetic properties of materials at the temperature of liquid air. Alto-

gether he wrote more than a hundred research and descriptive papers. He was elected to the fellowship of the Royal Society in 1892 and received the Hughes Medal of the Society in 1910, he was also awarded the Albert, the Faraday and the Duddell Medals, and in 1929 he was knighted.

As a teacher Fleming was superb. He had the gift of arranging his subject-matter attractively and of stating his facts and ideas emphatically. He talked straight on, without digressions, doublings, or repetitions, in a direct current of well-chosen words and rounded sentences. His delivery was very rapid, but his resonant voice and crisp articulation ensured that no one missed a word. Nor did anyone ever complain at his meaning was doubtful, everything was sharply defined. After middle age he became very deaf, but retained all his magic as a lecturer. This deafness, by the way, was utilized by his students when in jubilant mood, on such occasions a stranger passing the door of the lecture room might hear a sudden clamour and its sudden cessation, and if he lingered he would hear the uproar switched on and off at intervals. Inside the lecture room he would have seen that when the professor turned to the blackboard there was pandemonium, and when he faced his class there was silence. The timing had to be as reliable as Fleming was quick in his movements. This alertness was characteristic, even when he was in the middle seventies, one could see his linear figure reading swiftly a populous corridor in the College, intent on a goal, looking neither right nor left, overlooking everybody. Indeed in intellectual as well as in material things, Fleming's main principle of action was, full-speed ahead.

W. H. ECCLES

Dr. David Randall-MacIver, F.B.A.

DR. D. RANDALL-MACIVER, the accomplished chæologist and anthropologist, was born in 1873, and educated at Radley and the Queen's College, Oxford, where in 1896 he obtained a first class in *terce Humaniores*. It had been his youthful ambition to devote himself to the pre-Columbian cultures of America, but as this seemed impracticable, he came easily under the influence of Sayce and Grenfell at Leiden's, and learned the technique of Egyptian excavation with Flinders-Petrie. He was the first holder of the Laycock Studentship for Egyptology at Worcester College (1900-6) and in 1907 directed the Eckley B. Coxe, jun., Expedition of the University of Philadelphia to Egypt and the Sudan, publishing with Arthur Thomson a detailed anthropometric study of ancient Egyptian skeletons.

When the British Association visited South Africa

in 1904, Randall-MacIver was entrusted with a reconnaissance of the 'Zimbabwe' type of ruins in Rhodesia, and his rapid but careful and conclusive excavations on a few typical sites demonstrated their date, and caused some indignation locally when they were published in his "Mediaeval Rhodesia". After some work in the Pennsylvania Museum, he came librarian of the American Geographical Society (1911-14), married an accomplished Virginian lady, and seemed to be settling down in New England. But the War of 1914-18 recalled him to Europe as an efficient intelligence officer in France and in Macedonia—he spoke French, German and Italian with equal facility—and after 1919 he settled in France and devoted himself to the prehistoric antiquities of Italy, to which his attention had been

attracted by another Queen's man, the late T. E. Peet, whom MacIver had sponsored in his early years, and with whom, in a manner, he changed careers, when Peet left Italian prehistory for Egyptology. Peet's "Stone and Bronze Ages in Italy and Sicily" (1909) was a pioneer survey of the earlier periods, Randall-MacIver took up the story in 1924 with a stately volume, "Villanovans and Early Etruscans", tracing through tangled and sometimes passionate Italian publications the main theme of the continuity of native Italian culture, and its gradual transformation by the Early Etruscan, which intruded on its region from the south. In 1927 came a companion study of "The Iron Age in Italy", dealing with the cultures of central and southern Italy, neither Villanovan nor Etruscan, which betray early and increasing signs of intercourse with regions east of the Adriatic.

In this way a new approach was prepared to the residual problem of the Greek colonization, and of the foreign imports which portend the first renaissance of 'Magna Graecia'. To this, Randall-MacIver had intended to devote a third memoir, but his many social and personal interests and the death of his wife in 1931 intervened, all that he left on this subject was a charming book of travel, "Greek Cities in Italy and Sicily" (1931). In 1936, he married another American lady, and on the outbreak of war in 1939 withdrew from Italy to New York, where he was able to do valuable services in the British war organization. There he died on April 30, 1945.

JOHN L. MYRES

Prof. Thomas J. Nolan

THE news of the death of Prof. Thomas J. Nolan on March 12, at the age of fifty-six, came as a profound shock to his colleagues and students.

Graduating in University College, Dublin, in 1909 with the highest honours in chemistry, Nolan commenced research work under the late Prof. Hugh Ryan and was awarded a travelling studentship in chemistry in 1911, his thesis dealing with a research on "The Higher Ketones and Secondary Alcohols derived from the Amides of Palmitic and Stearic Acids". In the autumn of 1911, Nolan proceeded to Geneva and commenced research under Amé Pietet on problems dealing with the "Constitution of Isostrychnine" and the "Application of Methylal in Ring Syntheses". Owing to the illness of Pietet this work was not completed. In 1912 he began research under Prof. Samuel Smiles in University College, London, on the "Isomerism of the Sulphides of β -Naphthol", the results being embodied in a series of five papers in the *Proceedings and Transactions of the Chemical Society*, London. In 1913, Nolan worked under Zimcke in the University of Marburg and published in *Liebigs Annalen* a communication entitled "Salpetersäurechinitrol aus 3 5 6 Trichloro-o-Kresol und Umwandlungsprodukte". His most distinguished work at this period was carried out in the Kaiser Wilhelm Institut in Berlin, where Willstätter was engaged on his classic investigations on the colouring matters of flowers and fruit. Under Willstätter's direction Nolan succeeded in isolating the pigments of the rose and peony in a pure condition and establishing their constitution. The outbreak of war in 1914 terminated these researches, and he returned to Dublin and was awarded the D.Sc. degree of the National University.

During 1915-25, Nolan was engaged as research chemist to Messrs Nobel's Explosives Co., Ltd., during which period he carried out many valuable researches. In 1925 he returned to Dublin to become assistant State chemist and afterwards State chemist, a post which he held until his appointment in 1932 as professor of chemistry in University College, Dublin.

Much of the research which Nolan carried out during the past thirteen years was directed towards the investigation of the chemical constituents of lichens found in Ireland. In this very difficult field he was the first to isolate a chlormated depsidone, gangaleoidin, and had gone far towards establishing the constitution of this and other organic substances containing chlorine, which are found in lichens. More recently, he had isolated two nitrogenous constituents in the lichen *Lecanora epanora*.

Among his many activities Nolan served on the council of the Chemical Society, London, during 1926-29. He was chairman of the Board of the

Industrial Alcohol Factories established by the Irish Government, member of the Irish Industrial Research Council and during the emergency created by the War his advice was frequently sought and highly valued both by the State and industrialists.

Nolan was an inspiring teacher, a loyal and undemanding colleague, a staunch friend and a chemist of the highest calibre. His death at the height of his powers is a grievous loss to chemistry and to his University.

JOSEPH ALGAR

We regret to announce the following deaths

Prof. A. Fersman, the distinguished Russian geologist and mineralogist, aged sixty-one.

Sir Martin Forster, F.R.S., during 1922-23 director of the Indian Institute of Science, Bangalore, died May 24, aged seventy-two.

Mr. G. C. Robson, formerly of the British Museum (Natural History), where he was in charge of the collection of Mollusca, on May 17.

NEWS and VIEWS

Geology at the University of Sheffield

Prof. W. G. Fearnside, F.R.S.

Not a few of the younger generation of geologists will learn with surprise of the retirement of Prof. W. G. Fearnside from the Sorby chair of geology at the University of Sheffield. They will have ample ground for wonder whether anyone so patently young can have reached the age at which university professors retire, though the surprise may be lessened by the discovery that he has held the chair since its foundation thirty-two years ago, and consolation will follow the thought that geology still has the promise of his enthusiasm and energy for many years to come. Under McKenney Hughes, as a colleague of Alfred Harker, J. E. Marr, Henry Woods and Gertrude Elles, he commenced his geological career in some of the brightest days of the Cambridge school. It is not surprising that some of his earliest claims to distinction were notable contributions in the Cambridge tradition of Lower Palaeozoic geology, while his characteristic versatility was foreshadowed by his concern at the same time with the teaching of petrology and the collection of quaternary bones. During this period he was a fellow of Sidney Sussex College.

Shortly after his acceptance of the Sorby chair, Prof. Fearnside remarked on one occasion that the time had come to apply the lessons learned in the minute study of the lower Palaeozoic to the problems of the Coal Measures. His publication shortly thereafter of a structural map of the Yorkshire Coalfield laid the foundation of much work by himself and others, which has given greatly increased precision to knowledge of Carboniferous and post-Carboniferous earth-movements and their consequences. Among industrialists and engineers, Fearnside has performed a notable service in demonstrating the value of geology in those spheres, whether concerned with fuels, metals, refractories, bricks or roads. For him there is no 'pure' or 'applied' science. He is equally at home in the councils of the Institutions of Mining Engineers, or of Mining and Metallurgy, or in the presi-

dential chair of the Geological Society or of Section C (Geology) in the British Association. In the Royal Society his work for geology has been outstanding and all will wish that in this and other spheres may long continue.

Major F. W. Shotton, R.

Prof. Fearnside is being succeeded by Major F. W. Shotton, R.E. After a brilliant undergraduate career at Cambridge, Mr. Shotton was appointed to a lectureship at the University of Birmingham, where he worked under Prof. W. S. Boulton and Prof. L. J. Wills. During this time he carried out important work on the rocks of the Coventry district; he also studied the conditions of deposition of the Trias Sandstones with the aid of students from the University of Birmingham, whom he organized into teams for field-work. In 1936 he returned to Cambridge as lecturer under Prof. O. T. Jones and carried out detailed research in the Cross Fell district of the Pennine Chain.

In 1940 Shotton was asked to take an appointment as geologist with the Armies in France, but the next day for the appointment disappeared with the return of the B.E.F. to Great Britain. Shotton was eventually commissioned in the Royal Engineers in the autumn of 1940 and proceeded to the Middle East as geologist on H.Q. staff. Here he carried out excellent work mainly concerned with water-supply problems. In 1943 he was appointed as geologist to the Chief Engineer, Twenty-first Army Group, in succession to Prof. W. B. R. King. During the time before D-day, Shotton was busy studying many problems connected with the Normandy landings, particularly in connexion with the behaviour of various types of beach under different loads, and reaction to shell condition of river banks and bottoms, water supply and suitability of sites for the construction of landing strips for fighter aircraft. Shortly after D-day, he was in Normandy putting the results of this study into practice, and has been with the armies throughout their advance into Germany. During this time,

was justified to the full the appointment of a geologist to the staff of the Chief Engineer. His election to the chair of geology at Sheffield, while enabling him to return to the pursuit and teaching of pure science as a basic study, will enable him to continue to maintain and emphasize the value of geology to all civil engineering practice, as he has done to military engineering in its widest sense.

Chair of Geology at Leeds: Prof. W. Q. Kennedy

DR W. Q. KENNEDY, who has been appointed to the chair of geology in the University of Leeds, is a senior geologist on the staff of the Geological Survey in Scotland. Before joining the Geological Survey in 1928, Kennedy studied under J. W. Gregory in Glasgow and under Niggli in Zurich. As a result of his Continental training, he became one of the first geologists in Britain to apply Fedorov and Sander 'universal stage' technique to the microscopic study of rocks, and early in his career published a translation of Chudoba's text-book on the determination of plagioclase feldspars by 'universal stage' methods. Kennedy has made notable contributions to geological research. In petrology he has dealt with pyrometamorphic ore-deposits, composite lava-flows, the parent magma of the British Tertiary Province and, in conjunction with Dr E. M. Anderson, the origins of basaltic magma. His conception of volcanic and plutonic associations has been acclaimed as a fundamental contribution to tectogenetic theory. Perhaps his most notable work in Scotland is his study of the Great Glen Fault, which led him to infer a lateral shift of some 65 miles along this fracture and to discuss its tectonic and metamorphic implications. His official Survey work with Dr J. E. Richey on the Moine and sub-Moine rocks of the Morar district has also produced notable results in Highland stratigraphy and tectonics.

Prior to the opening of the new Geological Museum in London in 1935, Kennedy spent a year or two in London preparing the ground-floor exhibits illustrating volcanicity and glaciology. During the war, he has been concerned with economic investigations on Scottish feldspar mica, iron-ore, l-shale, mineral oil, natural gas and dolomite. His re-war discovery of a valuable muscovite deposit in the Scottish Highlands has proved to be of national importance.

University Development at Birmingham

THE University of Birmingham has launched an appeal for £1,500,000 for purposes of development, and promises of £638,636 have already been received. Outstanding items in the proposed scheme are £100,000 each for four additional halls of residence (three for men and one for women), £200,000 for a new library, £170,000 for new laboratories for mechanical and electrical engineering, £150,000 for buildings at Edgbaston to house the Faculties of Arts, Commerce and Law, and central administration, and £100,000 each for the endowment of chairs of geography and electronics. In the words of the Vice-Chancellor, Dr. Raymond Priestley, "Men and women to must guide and control a great industrial people, and the experts who are to be the spear-point of scientific industry, are best educated within sight and sound of the factory and the market-place. We are moving forward into a world in which technical development will take place at an accelerating rate.

To equip ourselves for the competition we shall have to face in order to maintain our standard of living—if not our very existence—in the post-war world involves mobilization of the skill and talent of the whole people, together with development of character, to put the programme through. We need to combine the best features of the older universities with the specialities of the new that are in closer touch with the industrial world. Given the will and the apparatus, there is nowhere that this could be done better than here in Birmingham."

Industrial Ophthalmology

THE Institute of Ophthalmology, Royal Eye Hospital, St George's Circus, London, S E 1, proposes to devote a considerable proportion of its funds to industrial ophthalmology. In view of the absence of any co-ordinated work in this field, it is felt that a national survey of workers, and of work already accomplished, is a necessary preliminary to the undertaking of research on any specific aspect of this very extensive subject. The Institute therefore invites those who have routine experience in any branch of industrial ophthalmology, or who have undertaken original work bearing upon it, to communicate with the Institute stating briefly their experience and defining the aspect of the work with which they are most familiar—medical supervision, safety, lighting, industrial psychology, etc. It is the Institute's policy to promote the investigation of industrial ophthalmic problems in the districts in which they arise. It is hoped that those replying to this request will be willing to co-operate in their own areas and in their special fields of interest and experience as the national scheme develops. This invitation is extended not only to individual workers, but also to research and other organizations concerned. The funds will be distributed on the recommendation of the Scientific Executive Committee in the form of grants for approved work. The Committee proposes, initially, to support, co-ordinate and publish work undertaken throughout Great Britain.

Industrial Data in Britain

ACCORDING to an article in the *Board of Trade Journal* of May 26, 1945, the Board of Trade is to undertake, through the regional research sub-committees formed as adjuncts to the Distribution of Industry Committees, the collection and assembly, on a continuing basis, of a wide range of factual data required for distribution of industry purposes covering every locality in Britain. In making such surveys the Board of Trade will make the fullest use of information on industry already accumulated by the supply Ministries and by the Ministries of Labour and Town and Country Planning. It is also intended to take the fullest advantage of local knowledge by consultation with non-official bodies, whether universities, local authorities or industrial groups. By these means the Board of Trade should be made conversant with the industrial problems of all parts of the country and equipped to provide the industrial world with an information service to help individual firms in making decisions on the location of new factories.

Astronomical Observatory of Madrid

THE *Anuario* for 1945 of the Madrid Observatory has been prepared on a plan similar to that of the preceding issues, with some slight modifications intro-

duced in the year-book for 1944. Observations and records of solar activity during 1944 have continued, and the results, together with those made at the observatories of Valencia and Cartuja, have been sent to the International Bureau at Zurich. Time signals have been carried out, and photographs of comets and planets, occultations of stars by the moon and other notable phenomena have been included in the programme. *Boletín Astronómico*, 2, No 10, contains the results of observations of sunspots and prominences in 1938 and the positions of a number of comets observed in 1941 and 1942, while *Bol Ast*, 3, No 1 contains the results of solar observations made in 1939 and 1940, including also those made during the latter year at Valencia. Repairs were started in the Observatory, those to the astrographic pavilion being completed, and the installation of the instrument and the new cupola to house it will allow the renewal of observations. At the end of the year-book there is an interesting section containing 72 pages with the title "El Sistema Galáctico", by José María Torroja Menéndez. This provides a very useful summary of our knowledge of the galaxy.

Belgian Scientific Delegates in Britain

A THIRD group of Belgian professors representing the Belgian Fondation Universitaire is now visiting Britain for a fortnight at the invitation of the British Council. They are visiting universities or research institutions in London, Reading, Oxford, Cambridge, Newcastle, Aberdeen, Edinburgh, Liverpool and Greenwich, and the ICI works at Billingham. The delegates are Prof F. Van den Dungen, professor of analytical mechanics, University of Brussels, Prof A. Michotte van den Berck, professor of experimental psychology, University of Louvain, Prof A. Gratia, professor of bacteriology, University of Liège, Prof J. A. H. Rodham, director of the Institute of Tropical Medicine, Antwerp, Prof E. J. M. P. Mertenis, professor of industrial chemistry, University of Louvain.

Cambridge Summer School in X-Ray Crystallography

A SUMMER school in X-ray crystallography will be held again this year in the Department of Mineralogy and Petrology, and in the Cavendish Laboratory, Cambridge, during the two weeks September 3-14. The school is conceived as a means of providing an introduction to the fundamental theory, methods and techniques of X-ray diffraction, so that those whose researches, whether in the universities or in industry, lie in the field of physics, chemistry, metallurgy, mineralogy or biology may be able to recognize in their own work the types of problem to which these methods may with advantage be applied. The greater part of the course will be devoted to practical work on the interpretation of the various types of X-ray photograph. For the last two days, however, alternative lectures and demonstrations will be offered in two sections. One section will include further steps, theoretical and practical, in the study of crystal structures, while in the other some applications of the earlier work of the course to metallurgical problems will be studied. A detailed syllabus and form of application for admission may be obtained from Mr G. F. Hickson, secretary of the Board of Extra-Mural Studies, Stuart House, Cambridge, to whom the completed application form should be returned not later than June 23, 1945.

Announcements

THE following appointments in the Colonial Service have been made: W. J. Kinghorn, to be director of agriculture, Bermuda; Miss B. Y. Campbell, to be nutrition officer, Trinidad; T. A. Russell, director of agriculture, Bermuda, to be agricultural officer, Nigeria; N. M. Wight, agricultural officer, Tanganyika, to be senior agricultural officer, Jamaica.

At the anniversary meeting of the Linnean Society of London held on May 24, the following were elected officers for the year 1945-46: *President*, Mr A. I. Cotton; *Treasurer*, Colonel F. C. Stern; *Secretaries*, Dr B. Barnes (botany) and Dr Malcolm A. Smith (zoology); *New Members of Council*, Mr A. H. Alston, Prof T. A. Bennet-Clark, Dr F. C. Fraser, Dr H. S. Holden and Dr S. M. Manton.

At the annual general meeting of the Physics Society on May 23 the following were elected or re-elected for 1945-46: *President*, Prof D. Brunt; *Vice-Presidents*, Sir Edward Appleton, Prof Chapman, Prof H. T. Flint, Prof N. F. Mott; *Hon. Secretaries*, Mr J. H. Awwbery (*Papers*), Dr W. Jevons (*Business*), *Hon. Foreign Secretary*, Prof E. N. da Andrade; *Hon. Treasurer*, Dr C. C. Paterson; *Hon. Librarian*, Prof L. C. Martin; *Council*, Prof J. Bernal, Dr B. Chalmers, Dr C. H. Collie, Mr E. Davies, Prof G. I. Finch, Dr W. B. Mann, Mr A. Philpot, Dr D. Roaf, Prof H. R. Robinson, Dr J. Shaw, Dr W. S. Stiles, Dr W. D. Wright. The officers of the Colour Group for 1945-46 are: *Chairman*, Dr R. K. Schofield; *Secretary*, Dr W. Wright; and of the Optical Group, *Chairman*, Ins. Capt. T. Y. Baker; *Secretary*, Mr E. W. H. Selwyn.

At the annual general meeting of the Illuminatus Engineering Society held on May 15 the following were elected officers for the forthcoming session: *President*, Mr H. C. Weston; *Vice-Presidents*, Mr Howard Long, Mr H. E. Chasteney and Mr J. Waldram; *Hon. Treasurer*, Mr N. V. Everton; *Hon. Secretary*, Mr J. S. Dow; *Members of Council*, Mr J. N. Aldington, Mr M. G. Bennett, Dr W. Hampton, Mr A. G. Higgins, Mr J. S. Preston, Mr A. J. Pashler, Mr E. B. Sawyer, Dr W. S. Stilwell and Dr W. D. Wright.

At the meeting of the Board of the Finney-How Research Foundation, Inc., on March 2, fellowships were renewed for the third year for Dr Nelicia Marx for the second year for Drs Muriel Virginia Bradl and Margaret Aston Kelsall, and a new fellowship awarded to Dr Elizabeth Cavert Miller, to work at the University of Wisconsin. Applications for fellowships for 1946 must be made to the Foundation Medical and Chirurgical Faculty Building, 12 Cathedral Street, Baltimore, Md., U.S.A., before December 1945.

THE Leeds Branch of the Association of Scientific Workers will hold an open conference on "Science and Education" at the Philosophical Hall, C. Museum, Leeds, on June 9, at 2.30 p.m. It is hoped to discuss the teaching of scientific method in elementary education, the comparative value of science and the humanities in general education, a curricula for specialist technicians. Sir Robt. Watson-Watt will open the discussion and Dr W. Astbury will preside. Tickets of admission (price 1/-) can be obtained from the honorary secretary of the Leeds Branch of the Association of Scientific Workers, 95 Holywell Lane, Glasshoughton, Castleford.

LETTERS TO THE EDITORS

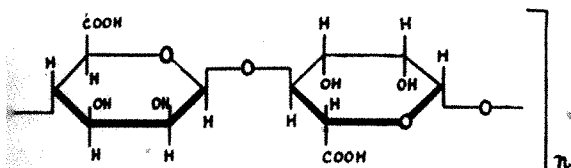
The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications.

Structure of Alginic Acid

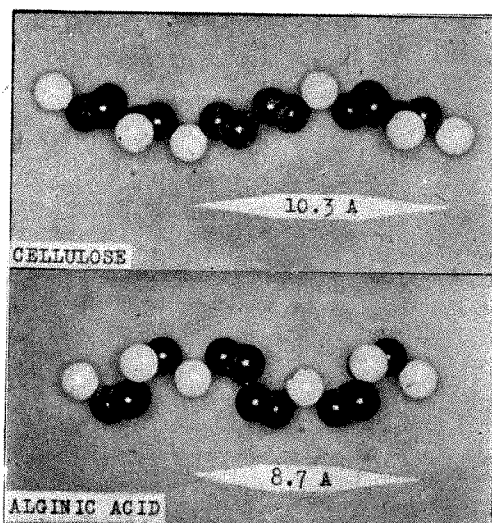
THE following is a short account of work completed a matter of two years ago; but publication at the time was forbidden. It was carried out in connexion with the production of rayon from seaweed described by Speakman and Chamberlain¹, and for the preparation of the fibres I am indebted to Dr. Chamberlain.

The alginic acid fibres finally arrived at gave at ordinary humidity a well-oriented X-ray diagram that could be evaluated without ambiguity. At this humidity the unit cell contains four mannuronic acid residues and perhaps four water molecules—it is difficult to be more definite than this, because both inter- and intra-crystalline water is present, and the density of the crystallites is not necessarily the same as that of the fibres as a whole; if we assume that it is, then the intra-crystalline water approaches four molecules per cell. Through the cell two chain-molecules run in opposite directions, one through the corners and the other through the middle of the (10) face, as in cellulose. On drying the fibres intensively the a -axis decreases and the X-ray pattern deteriorates; but the change is completely reversible on re-exposure to the atmosphere. From X-ray measurements the cell dimensions are: $a = 7.7$, b (fibre axis) $= 8.7$ A., $c = 10.6$ A. The space-group is probably Q^3 ($P2_12_12_1$), but it approximates Q^4 ($P2_12_12_1$). The dry density was found by Dr. Chamberlain to be 1.627 gm./c.c.

The evidence from X-ray analysis is all in favour of the pyranose formula for alginic acid² [see also p. 655]:



and interest centres therefore in why the period along the fibre axis should be 8.7 A. instead of the 10.3 A. and in cellulose. There is no reason from the properties of the fibres to think that the chain of β -D-mannuronic acid residues is not stereochemically fully extended, so presumably the cellulose and alginic acid configurations are alternatives derivable from common postulates. As already indicated in a previous communication on the structure of cellulose³, to find this to be so: there is no need to depart significantly from the usual interatomic distances and bond angles, and the Sachse strainless ring in the so-called 'armchair' form constructed to these dimensions suffices for both cellulose and alginic acid. The difference lies simply in this, that there are two possible directions of the bonds joining C₁ and C₄ to the glucosidic oxygens, and the flatter arrangement is found in cellulose and the other in alginic acid. The idea will be clear from the skeleton models illustrated. Taking the carbon bond angle to be tetrahedral, the oxygen bond angle to be 110°, C—C = 1.54 A., and C—O = 1.42 A.⁴, the calculated fibre period for cellulose comes to 10.3 A. and that for alginic acid to 8.7 A., as compared with 10.3 A. and 8.7 A. given by X-rays.



SKELETON MODELS OF THE CHAIN CONFIGURATION IN CELLULOSE AND ALGINIC ACID.

It is important to realize that the two configurations are not independent: one is not the prerogative of cellulose and the other of alginic acid, for in principle either may pass over into the other by intramolecular oscillation, as is easily seen on manipulating a model made with flexible bonds. The cellulose we know has one form and the alginic acid we know has the other, but it is conceivable that conditions, or derivatives, may be found for either that favour a change-over. For example, it has rather come to be expected that cellulose derivatives will be found always to have a fibre period that is a multiple of 5.15 A., and on this basis the 25.6 A. period of trinitro-cellulose has been assumed to correspond to the length of five residues; but it is not impossible that it corresponds actually to six residues in the alginic acid configuration. Similar remarks may apply to the 38.3 A. period given by α -camphor nitrocellulose-I⁵, which on current ideas would appear to correspond to $7\frac{1}{2}$ residues.

Another point worth emphasizing is that the two kinds of chain just described are not specially a consequence of the β -linkage. Our present fibre photographs of pectin are not as well resolved as those of alginic acid, but there can be little doubt that they are of the alginic acid type. But pectin is based chiefly on chains of α -galacturonic acid residues: the respective dispositions of hydroxyl groups in cellulose, alginic acid, and pectin are such that to produce the same result requires the β -linkage in the first two but the α -linkage in the last.

These findings, taken in conjunction with those of Cox and his collaborators⁶, go far towards establishing that the structural scheme for sugars formulated by Haworth and his school finds three-dimensional expression in the various configurations that are derivable simply by use of atomic distances and angles found to hold in less complicated aliphatic molecules, as, indeed, the sugar chemists themselves have long supposed. It is of great interest now to try to identify other theoretically possible examples besides the two discussed here, and also to determine what it is, in terms of physico-chemical conditions and the nature and arrangement of side groups, that decides the arrangement found in cellulose on one hand and that in alginic acid and pectin on the other. With

this end in view the investigation is being resumed with other polysaccharides.

I wish to record my thanks to Prof. J. B. Speakman and Dr. N. H. Chamberlain for supplying all the alginic acid fibres examined, to Drs. F. O. Bell, K. M. Rudall and M. M. Davies for much help on the experimental side, and to Prof. E. L. Hirst and his colleagues for guidance among the chemistry of the sugars.

W. T. ASTBURY.

Textile Physics Laboratory,
University of Leeds.
March 19.

¹ Speakman, J. B., and Chamberlain, N. H., *J. Soc. Dyers and Colour.*, **60**, 264 (1944).

² Lunde, Heen and Øy, *Koll.-Z.*, **83**, 196 (1938). Hirst, E. L., Jones, J. K. N., and Jones, W. O., *J. Chem. Soc.*, 1880 (1939).

³ Astbury, W. T., and Davies, M. M., *Nature*, **154**, 84 (1944).

⁴ See Pauling's "Nature of the Chemical Bond".

⁵ See, for example, K. H. Meyer's "Natural and Synthetic High Polymers", p. 280.

⁶ Cox, E. G., and Jeffrey, G. A., *Nature*, **143**, 894 (1939). Brown, C. J., Ph.D. thesis, University of Birmingham (1939). Cox, E. G., *Nature*, **154**, 84 (1944).

Residual Films of D.D.T.

IN the course of an investigation into the toxicity to houseflies of films of the insecticide D.D.T. deposited upon an absorptive type of wall-board, some observations have been made which may help to explain certain results obtained in field and laboratory tests by other workers.

Pieces of wall-board were sprayed with various concentrations of D.D.T. in 'Pool' burning-oil to give equal deposits of D.D.T. per unit area. After four days at 27.5° C. and 60 per cent relative humidity, flies were confined on the treated surfaces under petri dishes. From the data for toxicity to flies it was clear that, within the limits of the experiment, the highest toxicity was obtained from a given quantity of D.D.T. by applying it at a high concentration.

When the same samples were tested four weeks after treatment, those with the highest concentrations of D.D.T. had increased strikingly in toxicity. Microscopic examination revealed that, on those samples to which the D.D.T. had been applied in high concentration, the areas exposed to flies at the first test had become thickly carpeted with minute crystals of D.D.T. Further investigation has shown that D.D.T. has a great tendency to supersaturate or supercool, this tendency being greater with crude than with pure D.D.T. and greater when the solvent is 'Pool' burning-oil than acetone. Movement of the confined flies is sufficient mechanical agitation to induce crystallization of the relatively poorly toxic gum-like residue, a phenomenon which can also be initiated with a soft paint-brush. If the surface remains undisturbed, crystals do not form for at least several weeks and much of the potential toxicity of the D.D.T. residual film remains latent. The data supporting these observations will be reported more fully later.

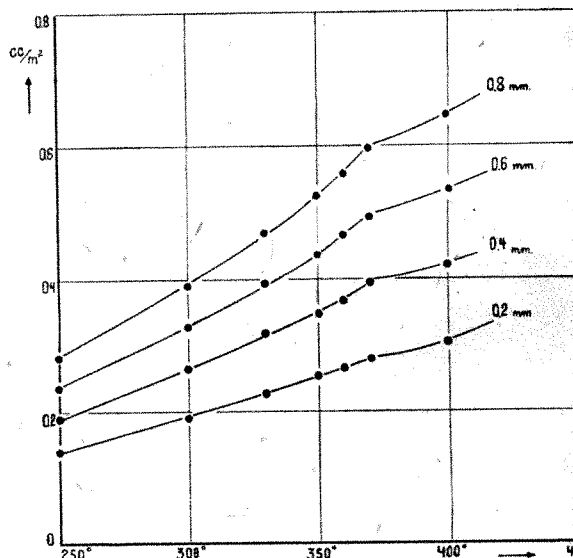
This work forms part of the programme of research of the Pest Infestation Laboratory, and this note is published by permission of the Department of Scientific and Industrial Research.

E. A. PARKIN.
A. A. GREEN.

Pest Infestation Laboratory,
Slough, Bucks.
April 16.

Activated Adsorption of Hydrogen in the Neighbourhood of the Curie Point

IN catalytic phenomena the ferromagnetic metal (iron, cobalt, nickel) possess a special interest. On the other hand, it is also known that adsorption phenomena are closely connected with catalysis. In continuation of systematic work carried out during recent years in this laboratory on adsorption phenomena, we measured the adsorption of hydrogen on nickel sheets between 200° and 400° C. The nickel is thoroughly cleaned by washing it successively with hydrogen and pumping off for several hours at 600° C. at a pressure lower than 10⁻⁶ mm. Special care is taken with the purification of the hydrogen. The measurements have been made with pressure up to 1 cm. It is found, first, that the equilibrium is very rapidly reached (30 sec.); secondly, adsorption increases with increasing temperature; thirdly, in the neighbourhood of the Curie point (358° C) the isobars show a very pronounced discontinuity (see graph).



Chevenard¹ and Williams² found also by means of measurements on the thermal expansion coefficient of nickel some discontinuities at the Curie point. These discontinuities are, however, too small to explain the phenomena observed by us. It is known that activated adsorption is connected with the electronic state of the metal, and at the Curie point this state undergoes some characteristic modifications.

Finally, our measurements on adsorption isotherms revealed partial reversibility for the adsorption.

A detailed report on these measurements will be published in the *Annales de Physique* (Paris).

A. VAN ISTERBEEK.
P. MARIÉNS.
I. VERPOORTEN.

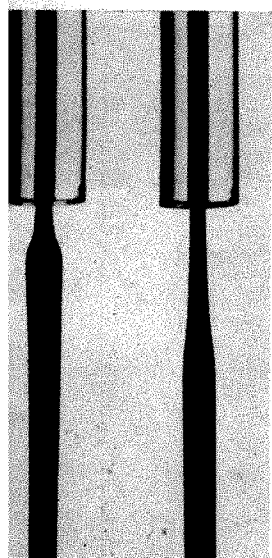
Physical Laboratory,
University of Louvain.
Feb. 23.

¹ *Trav. et Mém. Bur. Inst. des Poids et Mes.*, **17** (1927).

² *Phys. Rev.*, **48**, 320 (1934).

Elastic Recovery in Capillary Flow

IN a previous communication¹ the non-Newtonian behaviour of certain visco-elastic materials, including rubber solutions and soap-thickened mineral oils, was discussed. Experiment had shown that when such liquids flow through a capillary there is a loss in pressure at the tube entrance followed by a uniform fall in pressure down the remainder of the tube. This was shown to be large, particularly at high stresses, and if expressed in the form of an end correction, sometimes amounted to as much as fifty micrometers. The effect was attributed in a general way to the elastic nature of the material since it did not occur in Newtonian liquids or solid-liquid suspensions. In addition, this 'elastic end effect', as it was termed, was found to be related to the recovery or swelling of the column of liquid issuing from the capillary. Elastic recovery normally starts at the actual capillary end, but it has now been observed that at high stresses, corresponding to velocities of one or two metres per second, recovery is delayed. The delay becomes more pronounced if velocity is increased further, as the accompanying photographs show. All the materials and concentrations so far studied show this phenomenon.



7 m./sec. 5.5 m./sec.
Mean velocity.

It was also found that with certain solutions the onset of this delay coincided with an unmistakable 'kink' in the flow curve, indicating a sudden increase in the rate of flow.

It is not possible at this stage to state the exact cause of these anomalies—the delay in recovery and sudden increase in the flow-rate—but several explanations are possible. It might, for example, be due to slip at the tube wall. A more likely explanation, however, involves the question of time. At low velocities recovery is very rapid compared with the downward movement; but at high velocities the liquid may not be

able to make any appreciable recovery until it has moved some distance from the tube; hence the delay in the appearance of the swelling.

With normal recovery the swelling is usually very rapid (cf. Fig. 2¹) and it seems possible that this may act on flow immediately inside the tube, producing a small 'back pressure' tending to restrict the flow. This restriction would be removed when recovery took place well away from the capillary, and we could expect a sudden increase in the flow-rate at the transition. This idea seems to be supported by the fact that the 'kink' is apparent in precisely those materials which show a relatively large recovery (and consequently a large entrance loss); in cases where recovery is relatively small, no appreciable 'kink' occurs.

A. C. MERRINGTON.

6 Redford Road, Horsham,
Sussex. Dec. 29.

Merrington, A. C., *Nature*, 152, 863 (1943).

Internal Waves in the Sea

I AM just reading with great interest the important and excellent work by H. U. Sverdrup, M. W. Johnson and R. H. Fleming, "The Oceans: their Physics, Chemistry and General Biology" [Prentice-Hall, Inc., New York, 1942. See p. 652 of this issue of *Nature*]. I should like to direct attention to a lapse which I am rather anxious to have pointed out. On page 592 the first observation of internal waves in the sea is attributed to Helland-Hansen and Nansen. The fact is that such waves were discovered in the Great Belt two years before by the nestor of Swedish oceanographers¹, the late Otto Pettersson—well known as the originator of the international organization for marine research—and he also proved their tidal periodicity. Furthermore, on page 600 reference is incidentally made to observations of internal waves in a Swedish fjord which Otto Pettersson is said to have carried out "during 2 months of 1909". As a matter of fact, these observations were continued over several years², and—although particular theoretical conclusions which Pettersson inferred are open to serious criticism—the observations themselves are in their method by far the most exhaustive ever made.

These comments may seem to be of minor importance, but since internal waves have, of late, attracted the intense and increasing interest of oceanographers, and since Otto Pettersson himself was from the first aware of the importance of his discovery and took particular interest in it, I think we owe him the justice of acknowledging his priority, at the same time as we recognize the important contributions of Nansen and Helland-Hansen.

V. WALFRID EKMAN.

Gostad, Stockaryd,
Göteborg.

¹ Pettersson, O., "Strömstudier vid Östersjöns portar", *Svenska Hydrografisk-biologiska Kommissionens Skrifter*, 3 (1907). Also in "Ueber Meeresströmungen", *Veröffentlichungen des Instituts für Meereskunde* (Berlin, 1908).

² Pettersson, O., "On the Occurrence of Lunar Periods in Solar Activity and the Climate of the Earth", *Svenska Hydrografisk-biologiska Kommissionens Skrifter*, 5 (1914).

IN making the statement on page 592, to which Prof. Ekman refers, "that the first observations of short-period variations which indicated the existence of internal waves were discussed by Helland-Hansen and Nansen (1909)", the authors have in mind the short-period variations observed during the 1893-96 voyage of the *Fram*. Nansen realized that they might be due to waves at the boundary between waterstrata of different density, but it was not until 1909 that he and Helland-Hansen, persuaded by their 1900-4 observations in the Norwegian Sea, were convinced of the reality of internal waves.

In the meantime, Otto Pettersson had observed the rise and fall, with tidal periodicity, of the boundary surface between the poorly saline water from the Baltic Sea and the more saline undercurrent from the Skagerrak. Helland-Hansen and Nansen did not acknowledge this contribution although they were aware of it (p. 239; 1909).

Technically, at least, Pettersson's claim for prior discovery is well-founded, but it is obvious that the question was one under wide discussion at the time, and the Norwegian oceanographers would make a strong claim. It is quite possible that Prof. Ekman's own work on 'dead water', published in the results

of the 1893-96 expedition, played a great part in suggesting the correct explanation.

Oceanography has advanced too rapidly in the twentieth century to allow its text-books to include an adequate treatment of historical aspects. It would be a very good thing if a history of the subject could be written, while authorities whose basic contributions have been appearing since late in the nineteenth century can, happily, still be consulted.

G. E. R. DEACON.

Biliverdin as a Pigment in a Fish

In *Belone belone*, the garfish, the bones, scales and fin rays are of a bright green colour. The chemical nature of this well-known colouring matter has long remained unknown. It cannot be extracted from the tissues in which it occurs by any organic, or neutral, weak acid or alkaline inorganic solvent. But in stronger bases the green scales show a particularly clear transition to yellow, which can be turned back to green again in acids. In at least ten per cent alcoholic hydrochloric acid, the green colouring matter quickly becomes a blue-green in solution and can be separated with chloroform. It gives a clear Gmelin reaction and shows in its insolubility all the typical characteristics of biliverdin.

Thus, a gall pigment has been found in invertebrates for the first time, together with other pigments, as a colouring matter of the integument.

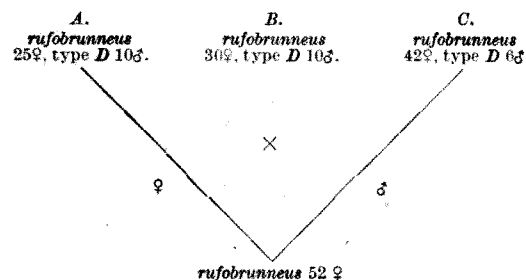
MELAHAT CAGLAR.

Zoological Institute,
University of Istanbul.
Feb. 1.

Genetics of Woodlice

I POINTED out recently¹ that my last brood of *Armadillidium vulgare* (Latr.), var. *rufobrunneus* Clge., nearly all died. Of the previous brood, the result of a cross between a female of *rufobrunneus* and a male of Howard's type *D*, I obtained the following interesting result. A brood liberated on October 26 consisted of 40 female *rufobrunneus* and 27 males of type *D*. Most of the male specimens have been consumed by the females of *rufobrunneus*. I secured, however, three females impregnated by one of the males of type *D*, and from these I have obtained three broods. All the specimens appeared to be sickly and most of them died.

Later, I placed a specimen of *rufobrunneus* from the brood A with a male specimen from brood C. The result was a brood of 52 females referable to the variety *rufobrunneus*, as shown below:



If we compare these two series of experiments (*Nature op. cit.*), and the present record, the following facts seem clear.

(1) That the female of the variety *rufobrunneus* crossed with the male of Howard's type *D* in the first generation produced more females than males in the second generation, there were more male than females, and in both cases all were referable to type *D*. In the third generation we find no specimens referable to type *D*; all belong to variety *rufobrunneus* and all are females.

(2) In the second experiment, described above the variety *rufobrunneus* dominates in three separate broods and the bulk of the progeny were female namely, 97 females and 16 males. In the final brood all the specimens were referable to the variety *rufobrunneus* ♀.

(3) It would appear from these experiments that the variety *rufobrunneus* was a dominant form, and while the type *D* makes its appearance, in only one instance did it exceed the number of females.

WALTER E. COLLINGE.

The Hollies,
141 Fulford Road, York.

¹ *Nature*, 154, 797 (1944).

Colour and Growth of Hair in Rabbit

HADDOW *et al.*¹ have recently reported that the growth of hair on the rat appears to take place as a series of waves symmetrically disposed about the longitudinal axis. They support this view by studying the disposition of a flavin dye, which, after injection, colours the hair of albino rats in a pattern corresponding to the most rapidly growing hair. They record the areas of regeneration of depilated hair and show that the blood capillaries are most dense in the areas of rapid growth.

Rabbits have been depilated here for many years in order to study either vaccinia lesions or the behaviour of 'diffusing factor' (hyaluronidase). Observations made concerning the growth of hair on the rabbit may be of interest.

Hair growth on the rabbit appears to follow a similar course to that reported for the rat. In rabbits with coloured hair the waves of rapid growth are disposed symmetrically about the longitudinal axis and can be observed on the depilated animal as raised coloured areas varying from about 0.5 to 5 cm. wide and usually stretching from the ears to the hindquarters. Close examination of these areas shows that they are coloured because they contain pigment in the hair shafts. When the hair has ceased active growth the proximal half of the shaft is white, pigment being restricted to the distal part. Hence the skin regions of restricted growth appear white. Varieties of rabbit such as the Flemish Giant have hair, each shaft of which has bands of different colour. The bands always appear in the same order, and hence by noting the colour of the shafts just emerging from the skin an estimate may be made of the direction of the growth wave. The younger hair is always the ventral edge of the wave, and from this it is deduced that the waves spread from the dorsal to the ventral surface of the animal. In albino rabbits rapid growth of hair seems to occur in raised hyperaemic areas in which the pink colour suggests dilatation or abundance of skin vessels. These areas are 'spongy' if injected with a needle. Hyperaemia and thickening of the skin in these areas of rapid hair growth are always more pronounced on the ventral edge, the whole area appearing as an escarpment facing downwards. In adult animals these waves of hair grow

usually occur in spring and autumn. Young growing animals show areas of rapid hair growth more frequently and do not show the same seasonal incidence. No such areas have been noted on depilated guinea pigs.

Hair growth on the rabbit may be artificially modified by agents that induce localized hyperaemia. For example, in animals which have recovered from vaccinia lesions the hyperaemia engendered by the vaccinia pox persists and a strong growth of hair frequently occurs exactly over the sites of the healed vesicles. This hair appears to be quite normal except that it is surrounded by relatively bare areas in which no vesicle, and therefore no hyperaemia, has occurred. Similar growth takes place after the intracutaneous injection of small doses of diphtheria toxin.

These observations correlate well with the experimental results of Haddow *et al* that "by far the greatest density of capillaries occurs in those positions which correspond to the advancing edge of the growing hair—" and that "it is likely that the pigment (the flavin dye) enters growing areas partly because these are the only ones in sufficiently active interchange with the general circulation." From the observations on the rabbit reported here it appears likely that both rapid growth and natural pigmentation of the hair shaft in this animal are correlated with local increased blood supply to the hair follicles.

C W HALE

Imperial Institute of Preventive Medicine,

Elstree, Herts April 14

Haddow, A., Elson, J. A., Roe, E. M. F., Rudall, K. M., and Timmis, G. M., *Nature*, 155, 379 (1945)

Feeding Twitch Rhizomes as an Alternative to Hay

TWITCH, or couch, grass (*Agropyron repens*) is among the common weeds which are difficult to eliminate. It is widespread, and persistent 'cleaning' of the soil seldom eliminates the whole stock, even more serious is the widely dispersed pest in hedge banks and other uncultivated plots. It is not only distributed by air-borne seeds, but it also extends rapidly by the creeping roots or rhizomes.

The roots or rhizomes are palatable and pigs are known to be fond of them. They also proved palatable when fed to domestic rabbits.

The chemical composition of dried roots of twitch showed them to be somewhat similar to meadow hay of good and lower-grade qualities, the rhizomes contain less fibre and somewhat less protein and mineral matter but, compared with cereal straw, rhizomes appear to be superior in protein and carbohydrate content.

COMPOSITION¹ SHOWN BY ANALYSIS

	Dry Matter	Protein	Oil	Carbohydrates Sol	Fibre	Ash
twitch rhizomes (dried)	85.0	5.0	0.6	56.5	19.8	3.1
meadow hay, poor	85.7	7.5	1.5	38.2	33.5	5.0
" " good	85.7	9.7	2.5	41.0	26.3	6.2
" straw, winter	86.0	1.9	1.5	43.1	34.6	4.9
" " spring	86.0	2.9	1.9	42.4	33.9	4.9

The shortage of hay supplies, following the 1944 drought during the growing season, has accentuated the need for hay substitutes^{2,3}.

Several palatability tests proved that rabbits ate the rhizomes more readily than rough grass hay and was therefore decided to carry out a small feeding trial.

Feeding Rhizomes Eighteen resting female rabbits of Bevers type were divided into two similar groups. All but one in each group were yearlings, the other was approximately three years old. The basal maintenance diet consisted of succulents, green-food (of variable quality, according to seasonal supply, but similar for both groups) and/or roots, supplemented by meal mash containing minerals and cod liver oil. Water was provided. The control group received rough grass hay, cut from poultry runs, while the other group was given dried twitch rhizomes of common couch or twitch grass.

The hay supply consisted of hard fescue and tall oat grass, cocksfoot, smooth-stalked meadow grass, foin, Yorkshire fog and a trace of clover. The species predominance was in that order.

The rhizomes were harrowed out and then forked over and air dried. They were relatively clean in appearance and were stored and fed in this state for the first eighteen weeks of the trial. During the remaining period, freshly dug roots were used, but owing to excessive soil adhering to them they were washed and air dried, although the time of year (November) precluded complete drying of this supply.

During a preliminary week, it was found that average daily consumption rates were, hay 0.75 oz and rhizomes 1.06 oz. Therefore the supply was restricted averaging 0.7 oz per head per day in each group.

Throughout the period of feeding unwashed and dried rhizomes, this group maintained a slight advantage in live weight over the controls fed on hay. After the change-over to freshly dug rhizomes the twitch group continued to give slightly heavier body weight in all but three weeks in spite of the reduced dry matter intake.

At the conclusion of twenty-five weeks of feeding twitch grass rhizomes as a substitute for hay the average live weight had increased in the hay group by 3.70 oz, and in the rhizomes group, 4.91 oz.

The condition of the animals was good, although they were moulty at the commencement, and improved as they moulted through. Health was excellent, with one exception in each group. An older one in each group died in the tenth week on twitch, and eighteenth week on hay. The respective post-mortem examinations by the veterinary officer revealed nephritis (twitch) but examination for sand was negative, and abscesses on the spleen and liver (hay). The rest of the stock remained free from symptoms of disease. The coats appeared to be slightly silkier on rhizomes than hay at the end of the seventh week, but after the feeding of freshly dug rhizomes the tendency appeared to be reversed. While there were differences between individuals within groups, the differences between groups were not outstanding, and appeared to depend largely on the stage of the moulting process.

Summary Air-dried twitch grass rhizomes, either washed or otherwise, were found to be palatable to domestic rabbits. The rhizomes were less bulky than an equal weight of rough grass hay and were eaten more quickly, and they proved to be a satisfactory substitute for hay when fed in maintenance rations for 175 days.

W KING WILSON

Harper Adams Agricultural College,
Newport, Shropshire

¹ *Min Agric Bull* No 124 (1942).

² Wilson, W King, *Nature*, 147, 796 (1941).

³ Wilson, W King, *Harper Adams Util Poultry J*, 29, 45 (1944).

Non-luminous Flame Gases

PROF W T DAVID and his co-workers have published a moving-film record of the passage of flame gases along a glass tube¹. Such records have frequently appeared elsewhere², but the explanation given by the writers of the letter, namely, that "the flame gases, although luminous after the early stages of flame-front travel from the igniting spark, suddenly become non-luminous after further travel (due apparently to a sudden change in the mode of combustion in the flame-front)" is a mis-reading of the photograph.

The apparent luminosity persistence after the spark has passed, and behind the flame front, is due to the elongation of an expanding ellipsoidal shell of flame, so that the later luminosity is that of freshly ignited gas. A detailed description and explanation of such records was first published in 1928³.

W PAYMAN

Safety in Mines Research Board,
Research Station,
Harpur Hill,
Buxton, Derbyshire

¹ *Nature*, 155, 273 (1945)

² See, for example, Ellis, *Fuel in Science and Practice*, 7, 409 (1928)

³ Payman, *Proc Roy Soc A*, 120, 90 (1928)

THE long duration of the "later luminosity" or "after-glow" militates against Dr Payman's view, and, indeed, its incorrectness is demonstrated by Dr Ellis's instantaneous photographs (see, for example, *Fuel in Science and Practice*, 7, No 9, 410, photographs Nos 8-10)

W T DAVID

Engineering Department,
The University, Leeds, 2

An Illusion of Size

If one looks at two nickel threepenny bits, a brand new one and a mat old one, with reduced illumination, the old one appears considerably bigger. The difference is striking if the illumination is correctly chosen. Out of fifty people, two only did not see the phenomenon immediately, even those two recognized it when the experiment was repeated. Older people realized it quicker than younger ones. Colour does not play any part, as the same difference is recognizable with shillings.

The phenomenon is obvious with a neutral or dark background, but is not provoked, or it may be inverted, when the two objects of different light value are viewed against a white background. Here the new coin sometimes appears bigger than the old one, when light is reduced.

The only explanation of the effect which I can offer is as follows. The old coin appears fogged when light is reduced, while the shining new piece of metal reflects light and is seen sharply. We are accustomed to linking a greater distance with a fogged object and therefore to over-estimate its size. Thus the moon seen through thin clouds appears bigger than a clear shining one, and misty hills seem to be at a greater distance than those sharply outlined and the size of the latter is correspondingly undervalued (Luckiesh¹).

This explanation is supported by the fact that the difference of size is more impressive after some seconds, as the phenomenon is psychological and not

a purely physical one. If we use a white background the experiment fails. It seems that there is not sufficient light reduction to create the adequate dimness of the old coin, while irradiation may interfere in the case of the new one. Using Ostwald's colour papers as background, I found that variation of colour does not influence the intensity of the size illusion but that different greys of the *A - P* series produce it sufficiently, the darker greys being no better than the middle ones.

ARNOLD LOEWENSTEIN

Department of Ophthalmology,
University, Glasgow

¹ Luckiesh, "Visual Illusions", 166 (New York, 1920)

Avoidance of Obstacles by Bats

MR OLIVER G PIKE, in his interesting article on bats in *Nature* of January 27, suggests that these creatures avoid obstacles in the dark by means of "a sense of which we know little, and to which it is very difficult to give a name, but which appears to be connected with the 'earlet' and the 'horseshoe'". These organs, *combined with their keen sense of hearing*, assist them to dodge all obstructions, and to find insect food while flying in the dark" (my italics).

The phrase in italics contains the key to the problem. Recent work in America by Galambos and Griffin^{1,2} has shown that the mechanism of obstacle avoidance by bats depends on their utterance of supersonic cries, the echoes of which from insect prey or obstructions are picked up by the cochlea. The 'stereoscopic hearing' resulting from central analysis of these supersonic echoes compares very favourably with binocular vision. It is interesting to reflect that a biological application of principle now widely used for the detection of military target has thus been revealed.

A. K. MCINTYRE

R A F Physiology Laboratory,
at Royal Aircraft Establishment,
South Farnborough, Hants

¹ Griffin, D R, and Galambos, R, *J Exp Zool*, 86, 481 (1941)

² Galambos, R, and Griffin, D R, *J Exp Zool*, 89, 475 (1942)

³ Galambos, R, *J Acous Soc Amer*, 14, 41 (1942)

Marine and Other Biological Laboratories

PROF J H. ORTON's article¹ contains certain inaccuracies as regards the status of marine biological laboratories in Scotland. First, the Millport Laboratory is not attached to the University of Glasgow, but is the property of the Scottish Marine Biological Association—an organization parallel with the Marine Biological Association of the United Kingdom to which the Plymouth Laboratory belongs. The Millport Station receives welcome aid from all the Scottish universities, more particularly Glasgow.

Further, it might be pointed out that "St Andrew Nigg" has no meaning. The University of St Andrews owns the Gatty Laboratory at St Andrews, but the former station at Nigg was operated by the Fisheries Board for Scotland and not by the University of Aberdeen.

RICHARD ELMHIRST

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¹ *Nature*, 155, 550 (1945)

THE KELP TRADE

By DR V. J. CHAPMAN

Botany School, Cambridge

THE formation of the Scottish Seaweed Research Association last year stimulates one to inquire into the somewhat chequered history of what is now known as the kelp industry. At one time this assumed considerable importance in Europe and afterwards spread to the United States and Japan, the last-named country producing in 1929 some 7 per cent of the world's iodine entirely from seaweeds. The word 'kelp' itself properly refers to the burnt ash of seaweed, but has since been extended to include the living plants.

The beginnings of the kelp industry are associated with the need for soda in the manufacture of glass and the glazing of pottery. Some time in the seventeenth century the kelp industry had its origin in France, and soon became so important that Louis XIV gave the Royal Company of Glass Manufacturers in Paris the sole privilege of cutting annually between certain fixed dates all the suitable seaweed along the coast of La Hague. This had to be revoked because of local agitation among the farmers, who from time almost immemorial had used the seaweed as manure on the land. Its use in this fashion had enriched the coastal lands to such an extent that they were known as the *Ceinture Dorée*.

Soon after the turn of the century the kelp trade began to spread, first to Ireland, thence to Scotland, the Orkneys and to Norway. In Scotland the first cargo left the Hebrides in 1722 and the trade then started to flourish so much that by 1800 Scotland was said to have produced about twenty thousand tons annually. This is probably an over-statement, but it is likely that twelve thousand tons is more accurate.

In the early days of the industry the principal seaweeds used by the kelp burners were the bladder-racks (*Ascophyllum* and *Fucus* species) because they contained the highest proportion of soda. The manufacturers sought it as a less expensive substitute for material called barilla soda which had to be imported from Spain. There came a time, though, when the duty on barilla was reduced and then soon afterwards the mineral deposits of Stassfurt were discovered. Both these events, as might be expected, most loudly sounded the death-knell for kelp, but the price was at hand. This came in the discovery of iodine, and in the further discovery that the seaweeds (species of *Laminaria*) were rich in this new element. The first factories for the extraction of iodine were built in France soon after 1820, and by 1843 the trade was once more flourishing. This stimulus given to the kelp trade by the discovery of iodine did not persist for long, because in 1873 the discovery of the oil resources dealt the industry a blow from which it never recovered.

Both in France and the Orkneys there was opposition at the start to kelp-burning because it was thought that the fisheries would be damaged. In the Orkneys a number of trials even took place. Later, however, when the industry formed a livelihood for forty thousand people, the old Highland toast 'a high price to kelp and cattle' was witness of the change of mind.

When bladder-wrack was the principal source of kelp the right to cut it was a jealously guarded privilege retained by those whose land adjoined the beach, and in France a number of decrees laid down

the regulations. Thus we find that the rockweeds or *goémon de rive* are described as those which are attached to the ground and may be reached dry-shod at low water of spring tides, but we go on to learn that the regulation dry-shod means that the cutter can enter the sea *jusqu'à la ceinture*!

In France the oarweeds were cut by special workers known as *soudeurs* or *goémonniers* who had to obtain a licence, but in other countries there were often no restrictions and the submarine forests of the sea were open to all who cared to carry out the arduous work. A satisfactory method of harvesting these growing weeds is indeed one of the main problems still confronting present-day operators in Europe. Cast weed, however, seemed to come into a different category. It was evidently considered that this was more or less common property, and in order to ensure that no quarrels should arise from its collection, each town, hamlet or region drew up its own rules. Thus in the Orkneys when a 'brook of ware' was thrown ashore the laird's factor divided the cast into a number of lots, and each crofter took so many lots according either to his acreage or his rent. The actual site of the lots was settled by ballot. In France much the same practice was followed. In the Isle d'Ouessant, after a gale had blown a good cast ashore, it was the privilege of the oldest inhabitant to mark it out into equal portions. When this was completed each family was permitted to take away as many lots as there were members in the family, but were only allowed to collect them "when the lighthouses were extinguished".

The old method of burning the dry seaweed in open kilns was wasteful as much of the iodine was lost to the atmosphere. Indeed, Cauer¹ has maintained that the high iodine *maheu* of central Europe is directly attributable to this fact. This loss and the impossibility of drying seaweed in the winter led to a search for an improved extraction process. The chemist E. C. Stanford was most active, and he first proposed the char or distillation process². Stanford naturally met considerable and determined opposition to his new method from the conservative kelpers. In a great effort to try to convince them that his technique was superior, he arranged that one of the most experienced crofters should pit himself in a test against him (Stanford), and there was no doubt that Stanford produced the better product. But the Hebridean crofters are not thus to be readily daunted, and so the old kelper turned to him and said, "I have been making kelp for fifty years and more, and am I to be taught by a young Sassenach with no beard on his face to speak of!"

Later Stanford invented the lixiviation process, which is of considerable importance because by this technique he obtained alginate acid. This substance, discovered by Stanford, is likely to prove the most important product to be obtained from the brown algae³. A number of factories were built but the laboratory processes just described could not be made to work satisfactorily on a commercial scale and much money was lost, this contributed to the collapse of the industry as a whole. It is, one hopes, partly to avoid a repetition of this error that the Scottish Seaweed Research Association has been formed.

Variants of both the char and lixiviation processes have been evolved but none of these appears to have been more successful than the originals. A Russian technique is, however, of more than passing interest. The Russians are not employing the oarweeds but instead a red seaweed, *Phyllophora nervosa*, which grows

abundantly in the Black Sea and is very rich in iodine. Water containing the chopped alga is electrolysed at increasing potentials, iodine separating out at the lowest, then bromine and finally chlorine at the highest. The solution is then concentrated and further electrolysis yields mannite and alginates.

In the past mistakes have also been made by scientific workers in not paying sufficient attention to (a) season of the year, (b) type of locality, (c) age of material, (d) proportion of stipe to lamina in the sample. Here again the S.S.R.A. will, it is hoped, see that these gaps are adequately filled. If the kelp industry in a new form can be started again it should go far to improve the lot of the crofters in the Highlands and Isles of Scotland if their natural prejudices can be overcome. The poverty of these people has to be seen to be believed—the habitations compare unfavourably with many of our slums, and overcrowding in small, ill-lit and badly ventilated cottages with their heavy peat smoke atmosphere is the rule rather than the exception. Any effort, therefore, that will improve their lot is to be welcomed.

¹ Cauer, H., *Biochem. Z.*, 299, 69 (1938)

² Stanford, E. C., *J. Soc. Arts*, 10, 185 (1862)

³ Delf, E. M., *Nature*, 152, 149 (1943).

GENETICS IN RELATION TO DISEASES OF ANIMALS AND PLANTS

AT a joint meeting of the Association of Applied Biologists and the Genetical Society, held in London on March 23, the problem of the "Genetic Relations of Plants and Animals to their Pests and Diseases" was discussed.

Dr C. D. Darlington (president of the Genetical Society) opened the proceedings by emphasizing the two fundamental facts that all species of animals and plants vary genetically in their power of resistance to, or defence against, disease, and that all disease organisms vary genetically in their power and mode of attack, and in their resistance to our control methods. Variability is the rule rather than the exception or nature, but crop and stock improvement in the last fifty years had tended to reduce variability within the different cultivated races even to the extent of producing, at times, a homozygous pure line. One of the problems of the future must be to introduce new variation into the cultivated forms. He also discussed the power of plants to produce antibodies to a virus, and considered that the recent work of J. M. Wallace (*J. Agric. Res.*, 69, 187) showed that antibodies to a virus are produced by tobacco and that they can propagate themselves in the tomato plant, which cannot itself develop them.

Dr J. Hammond dealt with constitution in cattle in relation to pests and diseases, particularly as illustrated by the introduction of European cattle into the tropics. There they are particularly susceptible to local pests and diseases to which the native or other tropical cattle are comparatively resistant. European cattle have a higher level of tick infestation than the zebu, possibly due to their longer hair and higher body temperatures. There is no evidence of any immunity to tick fever in the zebu, but the resistance to its effects is much higher than in European races, and first crosses come much nearer to the zebu. Body temperature and respiration-rate

have been measured in crosses and back-crosses between zebu and European cattle under tropical conditions. Milk production and growth run parallel with their resistance to tick fever, and there is little doubt that they are all dependent on differences in physiological constitution connected with heat regulation at high air temperatures. New tropical breeds—for example, the Santa Gertrudis and the Philamin—are being formed to combine the productive power of European beef cattle with the heat-, tick- and disease-resisting qualities of the zebu.

Michael Pease discussed the inheritance of disease resistance in poultry. He said that it had been claimed that the virtual disappearance of fowl paralysis in recent years had been due to selective breeding. In the Cambridge flock the disease was first noticed in 1930, increased to an alarming peak in 1935, and thereafter declined to negligible proportions in the war years. This was typical also of other parts of the country. In spite of this, analysis of the breeding results year by year gave no evidence that inheritance played any part in the incidence of the disease. With regard to non-specific disease in poultry it was widely held that this was due to breeding from too young birds. A statistical analysis of chick and adult mortality at Cambridge had shown that the determining factor was not the age of the mother, but whether she died during the breeding season or survived. Mothers which died early during the season left progeny with an excessive death-rate. The age of death of the cock was without any apparent effect.

Dr J. S. Carr discussed the heritable susceptibility to cancer in the domestic fowl. The incidence is high in all breeds throughout the world, and it is generally considered that the majority of cases are due to the action of carcinogenic viruses, of which number are known. Using Rous No. 1 Serum as test virus and 6-8-week old chicks as host, it was possible to show that the main factor determining known growth was the genetic constitution of the host. From a flock of Brown leghorns it was found possible to build up by selection a line with very high resistance to this virus. The line was also resistant to other carcinogenic viruses and to a certain extent to chemically induced tumours.

Dr William Black discussed the inheritance of resistance to blight (*Phytophthora infestans*) in the potato. A wild polyploid (*Solanum demissum*) was used as the source of resistant genes. Three strains of blight, A, B and C, were isolated and four resistant phenotypes were differentiated as follows:

- | | | |
|-----|--------------------|----------------------------|
| (1) | Plants immune from | A, B and C |
| (2) | " | " " A and B but not from C |
| (3) | " | " " A and C but not from B |
| (4) | " | " " A but not from B and C |

As all these were immune from A it appears that this strain is less virulent than the others, but the difference in virulence between B and C appeared to be qualitative rather than quantitative. A series of parallel tests of derivatives of three species, *Solanum tuberosum*, *S. demissum* and *S. tuberosa*, led to the conclusion that immunity from A and B is controlled by two major genes, *Ra* and *Rb*. Plants carrying *Ra* are immune from the A strain, while plants carrying *Rb* are immune from both A and B.

Dr G. Cockerham discussed the genetical aspects of resistance to potato virus and particularly the problem of 'hyper-sensitiveness' which causes such rapid death of the tissues round the point of infection that the virus is unable to spread. This results in what is

lles 'field immunity' A single dominant gene N_x induces hyper-sensitiveness to several strains of virus X but not to other aberrant strains Another gene N_a determines hyper-sensitiveness to virus A, and in each of six cultivated varieties this is closely linked with N_x In the variety South-Esk, however, the two genes are independent Still another gene N_c determines hypersensitiveness to virus C which is a strain of virus Y No cultivated variety of potato hypersensitive to virus Y, but five clones of three ferent 'wild' species showed characteristic responses when infected in the laboratory Dr Cockerm believes that 'hyper-sensitiveness' is a character of significant value in virus control

Prof T J Jenkin gave a short account of work in connexion with disease and pest resistance at the Welsh Plant Breeding Station at Aberystwyth, which is concerned chiefly with the production of new varieties of oats, clover and herbage grasses By selection from mixed population a variety of oat, 75, has been produced which is highly resistant to rust (*Ustilago*), and the white winter oat variety, 81, is one of the most resistant to eelworm In clover, special attention has been paid to finding strains resistant to clover rot (*Sclerotinia trifoliorum*) and eelworm (*Tylenchus devastatrix*) Here the choice of breeding material is far wider than in oats owing to the heterogeneity of the crop and the heterozygosity of individual plants

In the discussion which followed the principal speakers, Prof W J B Riddell directed attention to the effect of the different varieties of *Pneumococcus* causing pneumonia In Glasgow, type II occurred with higher frequency than in Manchester, where type I was the most common Since the introduction of chemotherapy, type II had relatively increased in Glasgow.

Dr K. Mather mentioned the work of Lindstrom and his pupils on the bacterial wilt of maize In this disease the bacterium increases in virulence by passage through a resistant inbred line of maize, but decreases virulence by passage through a susceptible line In mixed inoculations the virulent strain is selectively favoured by resistant maize and the avirulent by susceptible lines.

Mr A. Crane discussed the effect of the use of 'monoclonal' crops and suggested that some of the dangers might be avoided by the regular production of short-lived clones or by the regular production of F_1 hybrids which are sufficiently uniform for commercial requirements Virus infection upsets uniformity even in clonal crops In some vegetatively produced plants the position has now been reached when as much care, or more, has to be given to the nursing of old clones as to their cultivation

F C Bawden did not agree that present available evidence proved the existence of virus antibodies in plants.

Dr H. W Howard said that at Cambridge experiments had been carried out to obtain potatoes resistant to blight, using *S. demissum* as the source of immunity, with results very similar to those obtained by Dr Mack at Edinburgh In F_2 and F_3 , however, there was some indication of the effect of modifying genes of importance He considered that the genetics of the parasite (*P. infestans*) needed more investigation Strains from single spores had not changed their virulence and the origin of new strains may be due to sexual reproduction.

R. Stenton suggested that the ratio of diseased individuals in a mixed population of unknown genetic

constitution might be found to be proportional to the number of recessives present.

Dr C B Williams (president of the Association of Applied Biologists), in summing up, re-emphasized the importance of keeping a high level of variability in the host plants or animals as a protection against possible new diseases in the future He gave a short account of work recently carried out by Dr S C Harland in Peru on the selection of cotton Harland started with a very large number of plants tested individually for a small number of commercially valuable characters, and selected for these only, leaving all other characters as variable as possible He avoids all self-fertilization which produces a large proportion of homozygotes in all characters both visible and invisible.

C B. WILLIAMS

ARCHAEOLOGICAL EXPLORATION IN SOUTH AFRICA

SEVERAL interesting articles on archaeological topics have been published recently in South Africa Prof van Riet Lowe and Prof. H Breuil have been studying a number of Stone Age sites in southern Mozambique, not so far from Lourenço Marques^{1,2} It is true that both reports are very much of an interim nature, and that, except for a page of pottery profiles in one of them, they are unillustrated, but they are important, for enough has been found to show that, archaeologically speaking, the area is going to prove of very significant interest. Early palaeolithic finds, including some of a Clacton-Abbevillian facies, occur along the foot-hills of the main mountain chain and in the river valleys At the time when their makers were alive, it seems that the sea coast lay farther inland than it does to-day. Later Stone Age industries occur nearer the present shore-line

Mr B D Malan, of the Archaeological Survey, has issued a handy little instruction pamphlet for the use of would-be excavators³ Of course, a pennyworth of practice *under supervision* is worth pounds of theory, but there is room for the latter, too It is perhaps a pity that no 'tips' for studying rock-shelter paintings and rock carvings are given

Prof. van Riet Lowe's notes on the laws in South Africa governing archaeological and vertebrate palaeontological research⁴ will be read with mixed feelings On one hand, certain classes of sites are limited in number, and once spoiled by well-meaning but untrained amateur investigators their evidence is for ever lost On the other hand, it is not too much to say that most of our archaeological knowledge to-day has been due to the devoted efforts of amateurs in the past Many an amateur excavator is as good, if not better, than his professional confrère To have a paid job as a prehistorian, whether in a Government department or at a university or in a museum, does not thereby endow the holder with the attributes necessary for a really good observer in the field If regulations are made too tight, the amateur's interest in the subject tends to flag and his intellectual energy to be transferred to other fields As a result the subject ceases to attract the general public, and a 'hobby subject' needs public interest if it is to continue to progress In South Africa, the law permits surface finds to be freely collected, but certain types of sites (sealed deposits) are taboo, and so is the "removal and export of vertebrate fossils", and many

official forms have to be filled in before they can be touched by the would-be investigator. Maybe this is a right move, if it can be enforced. Otherwise sites will be stripped by collectors and no records kept. Then indeed the evidence will be totally lost to science.

These problems equally apply to Great Britain. We must face the risk of total loss of valuable evidence due to ignorant amateurs, or the stifling of nearly all amateur effort by bureaucratic control. These are the twin horns of the dilemma. Probably the best solution lies in the education of the local archaeological societies and the growth of a public opinion which would ensure that the local society is approached for expert help before any amateur attempts are made to tackle a serious excavation. But even this is not quite so simple as it sounds.

M C BURKITT

- 1 "First Impressions of an Archaeological Tour of the Southern Extremity of the Colony of Moçambique" By Prof C van Riet Lowe and Prof Henri Breuil (Imprensa Nacional de Moçambique, 1944)
- 2 "A Contribution to the Prehistory of Moçambique" By Prof C van Riet Lowe (Imprensa Nacional de Moçambique, 1944)
- 3 "Excavation Method in South African Prehistoric Caves" By B D Malan *South African Museums Association Bulletin*, Dec 1944
- 4 "The Position of Archaeological and Palaeontological Research in Relation to Law" By Prof C van Riet Lowe *South African Museums Association Bulletin*, Sept 1944

FORTHCOMING EVENTS

Tuesday, June 5

ROYAL ANTHROPOLOGICAL INSTITUTE (21 Bedford Square, London, W C1), at 1.30 p.m.—Prof A R Radcliffe-Brown "African Gods and Christian Saints in Brazil" (postponed from May 8)

Wednesday, June 6

SOCIETY OF CHEMICAL INDUSTRY (NUTRITIONAL PANEL) (at Chemical Society, Burlington House, Piccadilly, London, W 1), at 2.30 p.m.—Dr D P Cuthbertson "Protein Hydrolysates: their Preparation and Clinical Uses"

ROYAL ENTOMOLOGICAL SOCIETY (41 Queen's Gate, London, S W 7), at 3.30 p.m.—Dr A G Hamilton "Further Studies on the Relation of Humidity and Temperature to the Development of African Locusts"

Thursday, June 7

THE LINNEAN SOCIETY (joint meeting with the ZOOLOGICAL SOCIETY) (at the Linnean Society, Burlington House, Piccadilly, London, W 1), at 4.30 p.m.—Dr C Leighton Hare "Some Features of the Structure and Life-history of *Evocaulon septangulare* With and their Bearing on its Geographical Distribution", Dr A Tindell Hopwood "Contributions to the Study of some African Mammals (3) Adaptations in the Skeleton of the Fore-limb of Lion, Leopard and Cheetah"

Friday, June 8

ROYAL ASTRONOMICAL SOCIETY (Burlington House, Piccadilly, London, W 1), at 4.30 p.m.—Discussion on "Extra-Galactic Nebulae", among the speakers will be Dr A Hunter, on "The Observational Details of the Resolution of Extra-galactic Nebulae into Stars", and Mr J H Reynolds, on "The Apparent Distribution of the Extra-Galactic Systems and the Validity of the Magnitude-Scale"

ROYAL INSTITUTION (at 21 Albemarle Street, London, W 1), at 5 p.m.—Lord Moran of Manton "Courage and Fear"

PHYSICAL SOCIETY (at the Physics Department, Imperial College, London, S W 7), at 5 p.m.—Demonstrations

Saturday, June 9

BIOCHEMICAL SOCIETY (at the Institute of Physiology, University of Glasgow), at 11.30 a.m.—Scientific papers

INSTITUTE OF PHYSICS (ELECTRONICS GROUP) (in the Fyvie Hall, The Polytechnic, 309 Regent Street, London, W 1), at 2.30 p.m.—Discussion on "Some Aspects of High Vacuum Technique" ("Glass-to-Metal Seal Design", introduced by Mr W J Scott, and "High Vacuum Pumps", introduced by Dr R Witty)

APPOINTMENTS VACANT

APPLICATIONS are invited for the following appointments on or before the dates mentioned

LECTURER IN THE DEPARTMENT OF PHYSIOLOGY AND BIOCHEMISTRY, King's College, Strand, London, W C 2—The Secretary (June 8)

LECTURER IN APPLIED MATHEMATICS at King's College, Newcastle-upon-Tyne—The Registrar (June 9)

ASSISTANT LECTURER IN PHYSICAL AND INORGANIC CHEMISTRY Queen Mary College (University of London)—The Acting Registrar Queen Mary College, c/o King's College, Cambridge (June 10)

AGRICULTURAL TRAINING OFFICER to organize training in agriculture of persons released from war service—The Executive Office Holland War Agricultural Executive Committee, 15 Market Place, Boston, Lincs (June 16)

LECTURER IN ELECTRIC ENGINEERING at Kendrick Technical College, West Bromwich—The Director of Education, Educational Offices, Highfields, West Bromwich (June 16)

SUB-LIBRARIAN at Bedford College (University of London), Regent Park, N W 1—The Secretary (June 20)

LECTURER IN CHARGE OF THE DEPARTMENT OF BOTANY at University College, Leicester—The Registrar (June 20)

LECTURER IN MECHANICAL ENGINEERING at Brighton Technical College—The Education Officer, 54 Old Steine, Brighton, 1 (June 2)

PRINCIPAL of Nottingham and District Technical College—Acting Clerk to the Governors, Education Office, South Parade, Nottingham (June 30)

LINACRE PROFESSOR OF ZOOLOGY AND COMPARATIVE ANATOMY University of Oxford—The Registrar, University Registry, Oxford (July 7)

SECRETARY OF THE ROYAL GEOGRAPHICAL SOCIETY—The Honorary Secretary (July 31)

PROFESSOR OF AGRICULTURE and also a READER IN PHARMACY in the University of Sydney—The Registrar (six copies of application stating age, experience, publications, medical certificate and recent photograph are required) (August 18)

LECTURER IN SOCIAL ANTHROPOLOGY in the University of Edinburgh—The Secretary (September 30)

PROFESSOR OF BOTANY, a PROFESSOR OF ECONOMICS, and a SENIOR LECTURER IN ZOOLOGY, at Auckland University College (University of New Zealand)—The Secretary, Universities Bureau of the British Empire, c/o University College, Gower Street, London, W C 1

PHARMACIST for the Northern Rhodesia Government Health Department—The Secretary, Overseas Manpower Committee (Ref 125 Ministry of Labour and National Service, York House, Kingsway, London, W C 2)

BOTANIST for the Intelligence Section of the Plant and Animal Products Department of the Imperial Institute, London, S W 7—The Establishment Officer

LECTURER IN BIOLOGY (woman) at Edge Hill Training College Ormskirk (now at Bingley, Yorks)—The Principal

REPORTS and other PUBLICATION

(not included in the monthly Books Supplement)

Great Britain and Ireland

Royal Institute of Chemistry of Great Britain and Ireland. Twentieth seventh Streatfield Memorial Lecture. Modern Methods of Preservation. By Osman Jones. Pp 30+6 plates. (London: Royal Institute of Chemistry of Great Britain and Ireland, 1945)

Journal of the Society of Glass Technology. Transactions, Vol. No 129. XI Coloured Glasses, Part 3. The Colours Imparted by the Non-metallic Elements, Sulphur, Selenium, Tellurium, and Phosphorus and the Compounds. By Prof. Woldemar A. Weyl. Pp 148. (Sheffield: Society of Glass Technology, 1944) 10s

The Development of Mathematical Logic and of Logical Positivism in Poland between the Two Wars. (Polish Science and Learning Booklet No 8, edited by the Association of Polish University Professors and Lecturers in Great Britain) Pp 48. (London: Oxford University Press, 1945) 2s 6d net

Ministry of Education. Pamphlet No 1. The Nation's Schools: The Plan and Purpose. Pp 32. (London: H M Stationery Office, 1945) 6d net

Society of Chemical Industry. Reports on the Progress of Applied Chemistry. Vol 28, 1943. Pp 517. (London: Society of Chemical Industry, 1945)

Falmouth Observatory. Report of the Committee, with Meteorological Notes and Tables for the year 1944. Pp 12. (Falmouth: The Observatory, 1944)

Other Countries

Thirty-second Annual Report of the Director to the Trustees of the Mellon Institute, covering Fiscal Year ended February 28th, 1944. The Third Year of War Research in Mellon Institute. By Dr E. Wedlern. Pp 29. (Pittsburgh: Mellon Institute of Industrial Research, 1945)

Union of South Africa. Department for the Interior. Report of a Committee appointed by the Public Service Commission to inquire into a Medical Benefit Scheme for the Union Public Service (English and Africans). By Public Service Medical Benefit Scheme Committee of Enquiry. Pp 46. (Pretoria: Government Printer, 1945)

Bulletin of the American Museum of Natural History. Vol. Article 6. A Preliminary Analysis of the Herpetofauna of Sonora. By Dr Charles M. Bogart and Dr James A. Oliver. Pp 297-4. (New York: American Museum of Natural History, 1945)

Air Department of New Zealand Meteorological Office. Professional Note No 2. The Atmospheric Circulation of the Ross Area. By C. Ramage. Pp 14. (Wellington: Meteorological Office, 1944)

Transactions of the New York Academy of Sciences. Series Vol 7, No 4. Electric Pulsations in Human Brain, by Dr T. Barnes, Moral Values, by Dr Charles Clark L. Hull, Interpretation of Andean Archaeology, by Dr Wendell C. Bennett. Pp 87-1. (New York: New York Academy of Sciences, 1945)

San Diego Society of Natural History. Occasional Paper No. An Annotated List of the Marine Algae and Marine Grasses of San Diego County, California. By E. Yale Dawson. Pp 85. (San Diego: Calif. San Diego Society of Natural History, 1945)

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MAN IN THE MODERN WORLD

MR MUMFORD'S aim in the series of volumes that opened with "Technics and Civilization" was to give a rounded interpretation of the development of modern man, and to show what changes in his plan of life are necessary in order to enable him to make the most of the vast powers that are now at his command. The third volume, which has now appeared*, deals with the purposes and ends of human development. Whereas in his former volumes Mr Mumford was concerned with the effect of technical and social factors on the condition of man, he is here concerned with that of symbols, or what he terms the 'idolum' which complements man's natural environment. By this term he understands a symbolic milieu of images, sounds, words, fabrications, and even natural objects to which man has attached a representative value. The ability to write symbols and respond to symbols, he says, is an essential difference between the world of brutes and the world of men. Communication, communion and co-operation, the three essential attributes of human society, all depend upon the acceptance of common symbols to which the same meanings, functions, and values are attached. They are not substitutes for experience but a means of enhancing it and enlarging its domain, and ritual, art, poetry, drama, music, dance, philosophy, science, myth and religion are all as essential to man as his daily bread. It is through the effort to achieve meaning, form and value that the potentialities of man are realized, and his life raised to a higher potential, and this survey of the condition of man attempts accordingly to emphasize those aspects of man's life that are usually neglected—his dreams, his purposes, his ideals, his utopias.

From this point of view, Mr Mumford sets out to survey in its social setting the whole history of the mind of man from ancient Greece to Nazi Germany, to describe the conditions of life, material and spiritual, in which thinkers and philosophers arose, to characterize and evaluate their teachings, and, finally, to find a fresh answer to the age-long questions: What is man? What meaning has his life? What is his origin, his condition, his destiny? Mr Mumford seeks to determine whether any regular trends are to be found in human history and whether these throw any light on future possibilities. But while he attempts no study of ethical ideals, of the purposes which men ought to pursue, he makes many excursions into philosophy, and enters judgments in that field which are at least provocative and may be irritating, though it is argument and not contradiction that in the main he will stimulate.

The task Mr Mumford has set himself is immense and may seem unmanageable, but a strong sense of historical continuity informs his attempt at synthesis. Sometimes this leads him to oversimplify the issues, to concentrate on the history of ideas and to neglect the task of delineating the conditions in which men actually lived. "The Culture of Cities" may indeed correct the impression of unity and coherence in

* The Condition of Man. By Lewis Mumford. Pp x+467+16 plates (London: Martin Secker and Warburg, Ltd, n.d.) 25s net

some of his descriptions in the present book, for Mr Mumford is here apt to concern himself too much with the spiritual side of the history of Western man, and his dramatic bias, as indicated in his chapter titles, tends to accentuate the weakness. He gives too much of the impression of a closed chapter to each epoch, rather than of continuous development. Nevertheless, the fundamental theme of the book is that man is a continually changing animal, his growth is not completed by biological fulfilment as mate and parent or by death, his nature is self-surpassing and self-transcending, his utmost achievements are always beginnings and his fullest growth leaves him still unsatisfied, while above his instinctive and automatic activities lies a whole stratum of purpose and meaning. Mr Mumford has attempted, not to trace lines of development, but rather to discover in each period of human history the forces which tend to encourage or thwart the realization of personality. In dealing with each age he weaves into a single pattern all that is known of its religion and art, as well as of its social and political organization. He often challenges accepted beliefs and opinions, but even when he fails to substantiate his own views sufficiently, he demonstrates the resources of the reservoir of human creativeness to be found in history.

So far as scientific workers are concerned, they may feel that the contribution of science is insufficiently stressed by Mr Mumford, and may be tempted to compare his book to its disadvantage with Whitehead's "Adventures of Ideas". But while Mr Mumford has been over-careful to avoid repeating the argument of "Technics and Civilization", he does justice to Bacon and Newton, and one of the most suggestive passages of the book is that in which he discusses the relation between science and the universities at that time, and the way in which science came to acquire a moral authority that had once been pre-empted by the Church.

When dealing with science and its implications, Mr Mumford is in fact at his best. In the last three chapters of his book, which are much the best written and most lucid, if not indeed also the most stimulating, he passes in review the nineteenth century and seeks to disclose the roots of the dangers threatening Western civilization and to formulate a basis for renewal. Here is indeed a sombre picture of societies dominated by intensified nationalism, of the triumph of the machine over human personality and of moral weakness rationalized with the help of theories in which brute impulse is given priority over reason.

A formidable mass of reading, not all of equal value, is represented by the bibliographies appended to his books, but it is in the writings of a man of science, Patrick Geddes, that Mr. Mumford finds the clue to the basis of renewal. Geddes' emphasis on the evolution of a more finely attuned and more complexly balanced expression of both personality and community, and his philosophy of life in which mechanism had constant place as the servant of life but never as its master, led him to an expression of citizenship akin to that which Mumford has already indicated in "The Culture of Cities". Geddes accepted social

responsibility in his life and work, and interrelated scientific investigation with social need, but the change he advocated was the unification of all the processes of life, the subjective and the objective, and the equal cultivation of the sciences, the arts, and the humanities.

Mumford's tribute to the work and teaching of Geddes is deserved, but while Geddes expressed Mumford's own view that the sundered fragments of the modern world will be unified, not by returning to their original simplicity but by advancing to a more highly developed synthesis and a more inclusive pattern of action, open always to the test of fresh action, to the challenge of fresh experience, and to inclusion of fresh ideas and ideals, Mumford's final chapter has much in common with General Smuts' conception of holism. None the less, this final chapter is not exhaustive in its analysis and rather deficient in the delineation of the ways in which the needs of personality and those of the community are to be fulfilled in due balance, is perhaps the most stimulating in the whole book. It is full of pertinent comments as we face the tasks of a post-war world, and is less sombre than most of the book, for Mr Mumford faces the future with hope. We are moving, he thinks, from an age of expansion to an era of stabilization, which will present an opportunity for a proper balancing of functions, and therefore for a richer development of personality. To make greater use of our vitalities and energies we must re-assert the primacy of the personal.

Mr Mumford points out that every gain in power, every mastery of natural forces, every scientific addition to knowledge has proved potentially dangerous because it has not been accompanied by equal gains in self-understanding and self-discipline. If he seems to be paraphrasing Smuts' own words to the British Association, but the last ten years abundantly attest the truth of his further observation that science which disclaims all interest in human values except the satisfaction of curiosity and the increase of manipulative skill, cannot be useful even in its limited sphere when the general dissolution of values leads to a contempt for science and a deliberate perversion of its values. The watchwords of the new culture must be cultivation, humanization, co-operation and symbiosis. Many of our present mistakes are due to statesmen, industrial leaders and administrators attempting to apply the ideology of the age of expansion to a social organization with entirely different requirements—an organization in which careful timing and spacing of activities, the provision of diversified opportunities and the balancing and interlocking of functions must take the place of spectacular one-sided advances.

While the conditions for stabilization have not yet appeared, the institutions that will turn this process to the advancement of society have not yet been developed. For working out the new social order we need active knowledge of the social environment, and the behaviour of men in social partnerships, their needs, their drives, their impulses, their dreams as indispensable as reading, writing and arithmetic to those trained to capitalize. The art of politics and the arts of enlightened behaviour and orderly commun-

ions must become the main field of new inventions, and here Mr Mumford enters a plea for a world language

The great gains made in technique during the last few centuries have been largely offset by a philosophy that either denied the validity of man's higher needs, or sought to foster only that limited set of interests which enlarged the power of science and gave scope to a power personality. Hence Mr Mumford puts first among our tasks of post-war reconstruction, not the physical re-building, but the laying in every department of our culture of the foundations for a new set of purposes, a radically different mode of life. "Civilizations," he observes, "do not die of old age—they die of the complications of old age," and the task for our age is to decentralize power in all its manifestations. Our first need is not for organization nor for the mobilization of organization that has become inflexible—but for re-orientation, a change in reaction and attitude. There are new organizations, large and small, set up under stress of war, on which we can draw, but we must bring to each activity and every plan a new criterion of judgment: how far it tends to further the process of life-fulfilment, and how much respect it pays to the needs of the whole personality.

There is no easy formula for this renewal, and the real needs further analysis. The question whether the age of expansion is ended should be explored more deeply if by expansion we mean increasing control over the forces of Nature, including human nature. But if Mr Mumford is sometimes incomplete it is always suggestive, and his book is one to be pondered by all concerned with the trend of civilization. As already indicated, it is not free from faults. Historically, Mr Mumford tends to defeat his own object by dramatizing episodes in a way that masks a continuous development of human culture, and a strong Socinian bias mars his presentation of Christianity. But as a social philosopher he has the confidence and forward-looking mentality of the Mannheim school, and the whole weight of the book thrown in support of an adequate programme of social research in the true sense of the word. He comes also in support of the planning school, but he is not balanced to be led into excess, and his emphasis is freedom to be achieved only when the new ordering of our environment has permitted the development of personalities capable of drawing upon immense stores of energy, knowledge and wealth without being demoralized by them. Above all at the present moment it is for its note of hope, the confidence with which, surveying the disintegration of civilization, he summons us to the task of re-integration, that Mr Mumford's work is most welcome and should be studied, particularly by scientific workers, whose contribution to the task he recognizes as only as he stresses its limitations. This is the voice of a prophet and interpreter, calling us to seek the truth rather than declaring it plainly, and, though the message is not new, the world picture is clearer, more coherent and more relevant to post-war tasks. In that General Smuts drew for the centenary of the British Association

PRIMITIVE PERSONALITIES

The People of Alor

A Social-Psychological Study of an East Indian Island. By Cora Du Bois, with Analyses by Abram Kardiner and Emil Oberholzer. Pp xi+654+32 plates (Minneapolis, Minn.: University of Minnesota Press, London: Oxford University Press, 1944.) 45s 6d net.

DR DU BOIS received her training in anthropology at the University of California. Her subsequent field-work among American Indians on the west coast of America led her to realize the dangers of supposing that we can deduce what individuals are from the institutions under which they live. "psychological orientations and techniques" need to be employed for this purpose, and analytic psychology appeared to her "to offer the greatest number of concepts with which the anthropologist could operate, although much of its theory, particularly in the field of social phenomena, seemed inept." Thus it came about that in 1935 she spent a year as a U.S. National Research fellow, in exploring "the bearing of various psychiatric approaches to personality formation within our own society", and that in the spring of 1936 and 1937 she collaborated with Dr Abram Kardiner in his seminar at the New York Psychoanalytic Society. Together, they reached the conclusion that field-work alone could test the validity of the procedures which these seminar discussions had indicated. Aided by funds contributed by Dr Kardiner, the Social Science Research Council of Columbia University gave Dr Du Bois the financial support which enabled her to carry out such field-work.

Dr Du Bois's choice fell on Alor, a remote island north of Timor, fifty miles long and thirty miles broad, in the (then) Dutch East Indies. There she arrived in 1938 and at once built herself a house, among some six hundred mountain people, in a district called, from the name of its largest village, Atimelang, and comprising four other villages. The Atimelangers, Dr Du Bois tells us, are predominantly Oceanic Negroids, with Oceanic Mongoloid admixture and with perhaps a strain of pygmy origin. About ten thousand of the coastal people of Alor are Mahomedans, the rest are pagan. In Atimelang she stayed for eighteen months, returning to New York in the winter of 1939-40.

This book, the principal fruit of her expedition, is divided into four parts. The first is introductory. The nine chapters of the second part, styled "psycho-cultural synthesis" (in which thirty-one pages of excellent photographs are inserted), deal with infancy, childhood, adolescence, marriage, sex, adults and institutions, some psychological aspects of religion and some personality determinants in Alor culture. The third part, by far the longest, comprises more than 360 pages and contains the autobiographies of eight Alorians, four men and four women who, the author believes, "represent, on the whole, average Atimelang adults". These autobiographies were recorded with the help of a native interpreter, about fifteen interviews, of an hour each, were accorded to each of these eight informants. The fourth part of the book describes the results of the four psychological tests she applied—the Porteus Maze tests (scored and briefly commented on by Dr Porteus himself), word associations, children's drawings and the Rorschach test (evaluated by Dr Emil

Oberholzer, an enthusiastic expert on this test) They were applied respectively to 55, 36, 52 and 37 Alorese, and must be regarded as tentative, exploratory efforts

To Dr Du Bois's presentation of 'the problem' in her first chapter Dr. Kardner adds an 'elaboration' (as she terms it) of somewhat greater length To the second part he also contributes its last chapter, and to each of the eight autobiographies he appends an analysis of the personality and a diagram of the 'character structure' of each informant, adding a final chapter in which he surveys the biographies as a whole and compares them individually The contributors of these biographies received payment for each of their attendances "It was understood," Dr Du Bois states, "that each session would begin with dreams of the preceding night," and sometimes she had doubts as to the genuineness of these dreams Sometimes, too, the interference, and indeed the very presence, of the interpreter acted as an obstacle to securing the complete confidence and truthfulness of the informant. Nevertheless, these autobiographies reveal striking individual differences in personality, and they contain an abundance of ethnographic material which would probably have been unobtainable by any other, less novel, method, and when Dr Du Bois felt compelled to intervene in the narratives, these occasions are meticulously indicated in the text Few psychoanalysts, if any, will quarrel with Dr Kardner's interpretations of this material care and caution characterize his analyses But such phrases as "the tonicity of the super-ego", "inflation of the parental imago" and "weak libidinal ties" must prove deterrent to those who, like the reviewer, are less familiar with Freudian terminology than he is His reasonable concept of 'basic personality' (or 'modal personality', as Dr Du Bois prefers to term it) recurs throughout the book It implies "the psychic unity of mankind"—arising from "the interplay of fundamental physiologically and neurologically determined tendencies and experiences common to all human beings being acted upon by the cultural milieu, which denies, directs, and gratifies these needs very differently in different societies" As Dr Kardner observes, "no two individuals subjected to exactly the same cultural influences will utilize them in exactly the same manner" But in each society there is a 'central', or 'modal', tendency

When, on her return to America, Dr Du Bois presented her material for discussion at the Columbia University seminar, Dr Kardner, we are told, employed a certain technique and reached certain conclusions But, he says, Dr Oberholzer, to whom the Rorschach test material was submitted, "was acquainted neither with the technique that I pursued nor with its conclusions, nor did I know what the conclusions of the Rorschach tests were likely to be When these conclusions were finally presented, the correspondence between characteristics common to all Alorese and the reconstruction of the 'basic personality structure' was truly remarkable Furthermore, the differences between Alorese and Western man demonstrated by the Rorschach tests were equally striking" The reviewer, however, is not impressed by the closeness of correspondence between Dr Kardner's and Dr Oberholzer's descriptions of the personalities of individual Alorese whom they each analysed

"It is not the purpose of the present account," Dr Du Bois explains, "to give a thorough ethnographic

description" of the Alorese This is obvious, and such details, which "must await separate publication", will receive a hearty welcome Her present work is a serious attempt to effect collaboration between modern anthropology and so-called 'depth psychology', in the field of social studies It is, a Dr Ruth Benedict observes, "a pioneering contribution to the study of personality in an alien culture"

C S MYERS

THE SCHOOL CURRICULUM

The Content of Education

By J A Lauwerys Pp 24 (London Association for Education in Citizenship, 1944) 4d net

Science in Childhood Education

By G. S Craig Pp 86 (New York Bureau of Publications, Teachers' College, Columbia University, 1944)

READERS of the *Spectator* will recall a recent article bearing the challenging title "Teaching the Wrong Things", and they will probably agree that the writer of the article made out a good case to say the least, for a revision of our notions of what should be taught in our schools The call for revision does not come directly from the teaching profession itself, partly because teachers are too much occupied with the social side of their work to think about departures from the traditional curriculum, and partly because their noses are kept to the grindstone by the requirements of external examination

That the problem is in the air, however, and that it is receiving attention by people who take an active part in schemes of thinking and planning for the future, is well exemplified by Mr Lauwerys' pamphlet "The Content of Education" The writer is well aware of the difficulties of the job he has so courageously tackled There are some who say that it does not matter what you teach so long as the children are kept busy and happy, others who say that it does not matter so long as children are put through the mill of strict mental discipline, and still others who seem to agree with the famous headmaster quoted by Mr Lauwerys, that it did not matter much what was taught in his school, provided the boys loathed learning it In his well-packed pamphlet Mr Lauwerys first reviews the actual content of existing curriculum and then proceeds to ask how it has all come about Then follows an exposure of failure of the curriculum to meet the needs of children, as those needs are seen from the sociological point of view Finally, definite proposals for reform are summarized, following the lines laid down by the Association for Education in Citizenship

Mr Lauwerys refrains from dealing radically with the usual list of 'subjects'—a word which has much mischief to answer for, but which cannot be dispensed with The most significant of the reforms suggested comes under the head of social studies "For a long time progressive teachers of history and geography have tried working at combined courses in their two subjects Some feel that this proposal needs extending" They desire that there should be courses in social studies consisting of "material taken from history, geography, politics, economics, anthropology, social psychology" Such courses are being successfully given both in Britain and in the United States They deal with problems studied under such headings in such a way that when the treatise

s taken to a higher level they "tend to crystallise out into these subject-divisions"

The work entitled "Science in Childhood Education", by the professor of natural sciences in Teachers' College, Columbia University, shows that dissatisfaction with the present 'content of education' exists in the United States no less than in Britain. The question discussed in this work is the position of science in the education of children. Though, says the editor of the series to which this book belongs, science in some form has a widespread influence on our day-by-day living and thinking, yet it has made very little headway in schools for children of less than fourteen years of age. The lag seems to be due to the inclination to look at science only in terms of 'specialised fields', that is, of the 'subjects' which trouble Mr Lauwerys. One cannot teach "physics, chemistry, biology and the others" to children, and no satisfactory scheme has been devised to meet the needs of children who are assailed on every hand by the marvels wrought by modern science.

Prof. Craig's work has been inspired, not by a desire to defend science as a vested interest, but by a concern for aiding children to use scientific procedures and information as a means of dealing with problems they encounter and of understanding their environment. He has performed his task with admirable thoroughness, but the teachers of American children must not expect to find the book easy reading. It is, however, an interesting confirmation of our own concern for meeting the real needs of twentieth-century children.

T RAYMONT

ELECTRICAL TRANSMISSION FREQUENCIES

High Frequency Transmission Lines

by Dr Willis Jackson (Methuen's Monographs on Physical Subjects) Pp vii+152 (London: Methuen and Co., Ltd., 1945) 6s net

DURING the early stages of the industrial applications of electricity, direct current held sway in both telecommunication and power transmission. Under the influence of Kelvin and Edison, direct current continued to be used for the latter purpose, long after the practical superiority of alternating current had been fully demonstrated. At present, all the most important power transmission is done at frequencies of 50-60 cycles per second. There are, however, great difficulties in the way of extending alternating current power transmission over distances exceeding say 400 miles, and much thought is being given to reversion to D.C. for projects such as the transmission of powers of the order of a million kW. The wheel has therefore turned almost all circle.

In telecommunication, the trend has been from the D.C. or zero frequency telegraphic systems towards radio frequencies of the order of 10^9 cycles/second. High-frequency transmission lines have been used extensively for telecommunication purposes during the last five years, and have improved the efficacy of channels to a remarkable extent. This improvement has involved revolutionary changes in sending and receiving apparatus, and in the form and constitution of the interconnecting cables. Short-wave radio-type equipment does the transmitting and receiving over or through special channels, the best known of which is the coaxial cable. The cable must be constructed

in such a way that there are no abrupt changes in its capacity or inductance per unit length, and the dielectric losses in the insulation must be as low as possible. Great success has been attained, and it is possible to transmit as many as forty-eight messages simultaneously over a single channel, with high efficiency.

As literature of this revolutionary development is for the most part confined to specialized technical journals issued by the great telecommunication corporations, Prof. Willis Jackson has supplied a real need by providing a convenient and reasonably comprehensive monograph on high-frequency transmission.

Power transmission engineers will be attracted by the title, but they will find little in the book which seems to relate to their everyday work of transmitting powers of the order of 100 MW and above over distances up to say 200 miles, unless they are prepared to go through the author's exposition in detail. If they do so, they will learn much that is of service in connexion with their more intricate problems, such as those involved in stability calculations, and in determining the effects of impressed voltage surges.

Telecommunication engineers, who must perforce remain acquainted with the 'telegraph equations', will be more at home with the author's methods, and should have little difficulty in bringing themselves up to date in the new field.

Prof. Jackson's method of exposition is essentially spartan. He gives only cryptic indication of what is actually achieved by the use of high-frequency transmission lines, and evidently expects that his readers should be satisfied to plunge into abstract study without being tempted by a recital of practical achievements. This omission will, in the reviewer's opinion, materially and unfortunately reduce the circulation of a valuable book. It should, however, be noted that among the miscellaneous applications mentioned by the author are metallic insulators for supporting circuits carrying very high frequency currents of constant frequency, a non-contact short-circuit, and a condenser which will pass direct currents. These are sufficiently startling to arouse interest in all thinking electrical engineers.

After an introductory chapter on applications of transmission lines at very high frequencies, the subject is developed in five main sections, namely, the basic equations for transmission lines propagating in the principal mode, the propagation characteristics of lines, the behaviour of terminated lines, resonant lines, impedance transformation—the use of the circle diagram technique.

Free use is made of differential equations and hyperbolic functions as a means of avoiding ponderous explanations, but clear and interesting physical explanations and comments are provided, wherever they are required.

Forty-four diagrams are included. Most of these are simple sketches such as might be drawn by a lecturer on a blackboard, and are of little permanent service. Those relating to the circle diagram are, on the contrary, clear and complete, and are potentially of great practical service, since accurate basic data are given to enable a serious reader to construct his own diagrams for definite applications. The style of writing is clear and interesting, but it is marred by an excess of 'verys' and phrases such as 'on the other hand'. The book is of convenient pocket size, and is a worthy addition to an excellent series.

COAL IN RELATION TO ATMOSPHERIC POLLUTION*

By DR A PARKER

Director of Fuel Research, Department of Scientific and Industrial Research

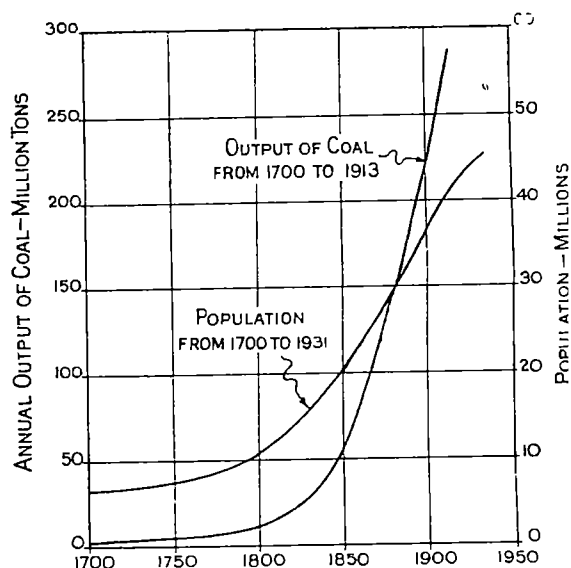
IN 1912, following an international smoke abatement exhibition in London, there was appointed an Advisory Committee on Atmospheric Pollution under the Meteorological Office. Later, in 1927, the work of this Committee was taken over by the Department of Scientific and Industrial Research. Under the guidance of the Atmospheric Pollution Research Committee of the Department, and with the co-operation of many local authorities, methods of measurement of different forms of atmospheric pollution have been improved and new methods devised, and systematic records of the extent of pollution in many parts of Britain have been obtained. The results of this useful work have been published in a number of annual reports of the Committee. Over a period of three years just before the War, an intensive survey of atmospheric pollution in Leicester was undertaken under the guidance of the Research Committee and a full report of this work is now in the press.

There is no doubt that all these activities have played their part in bringing about during the last fifty years a gradual but very definite improvement in many areas. There is much truth in the statement that the old type of London fog is now almost unknown. Much still remains to be done, however, before the air of our towns will be reasonably clean and free from smoke and other forms of pollution, and the ultimate goal will not be achieved except on the basis of intensive scientific research in several directions.

Quantity of Coal Used in Relation to Population

Before discussing the nature and the quantity of the polluting substances discharged into the atmosphere from the use of coal for different purposes, let us consider what changes have occurred in Great Britain since the beginning of the eighteenth century in the rate of production of coal, and in the relationship between the rate of production and the size of the population. This period is chosen because it was during the eighteenth century that there were the first signs of the beginning of the enormous developments in the use of coal which took place in the nineteenth century, particularly in the second half of that century. Great Britain has been fortunate in possessing reserves of coal of good quality and of many types. Early recognition of the possibilities in the use of coal for the generation of heat, power, and light, and the skill and enterprise of our scientific men, engineers and industrialists of 100-150 years ago, gave Great Britain a good lead in the industrial developments that followed.

The rapid rise in the use of coal was accompanied by a marked increase in the population. The great changes which occurred are indicated by the accompanying curves, which are plotted from estimates of the population and of the annual outputs of coal from the year 1700 to the early years of the present century.



The important changes in Great Britain during the last 140 years have thus included an increase in the annual output of coal from roughly 10 million tons to about 200 million tons, and a great increase in the population from roughly 10 to 45 millions, and the crowding of masses of people in large towns. Most of the coal brought to the surface in Great Britain is used in this country. If there had not been considerable improvements in the methods of using coal, atmospheric pollution from this source would certainly have been very much worse than it is to-day.

Efficiency of Use of Coal

In Table 1, figures are given to show the principal inland uses of coal in Great Britain and the quantities in millions of tons a year for the three-year period 1936-38.

TABLE 1 SOME USES OF COAL IN GREAT BRITAIN (ANNUAL AVERAGE FOR 1936-38)

	Purpose for which coal is used	Quantity in millions of tons
1	General use, including 40-45 million tons for domestic purposes	98
2	Electricity power stations	14
3	Coke ovens	20
4	Gas works	19
5	Railway locomotives	13
6	Collieries	12
7	Ships' bunkers, foreign and coastal	12
	Total	188

With what efficiency is the coal used for the various purposes mentioned above, and can the efficiency be increased? Unfortunately it is not possible from available data to do more than give very rough estimates of the efficiency of utilization of coal for the many purposes for which it is employed. The rough estimates that can be made, however, do serve as a useful guide.

Of the quantity of 98 million tons given in the first item of Table 1, approximately 40 million tons are used for domestic heating and cooking and 60 million tons by various industrial undertakings for such purposes as heating furnaces and raising steam for processes and for power. Though the efficiency of generation of steam in large boiler installations, the most modern type is often as high as 80 per cent, this high efficiency cannot be maintained unless the

* Substance of a Chadwick Public Lecture delivered on March 13

equipment is kept in first-class condition and is operated under close scientific supervision. In the past, coal has been relatively cheap, and in large numbers of industrial undertakings little attention has been given to equipment such as boilers and furnaces. Far too much heat, which could have been usefully employed in several ways, has been carried away in hot gases and liquids, and large quantities of steam have been wasted. With many furnaces of the kind used for heating metals, not more than 5 per cent of the heat value of the coal is put to useful purpose. It is difficult in furnaces of this kind to obtain high efficiency, but there is no doubt that appreciable improvement is practicable in many cases. As an overall figure, it is unlikely that the efficiency of use of the 60 million tons of coal included in the first item of Table 1 for industrial purposes exceeds 50 per cent.

On the domestic side, the overall efficiency of the open coal-fire under average household conditions is not more than about 20 per cent. The corresponding figure for the general purpose appliance in which coal is used for space heating, provision of hot water, and cooking is somewhat greater because of the heat taken up by the water, but it is probably not more than 25 per cent. Here is considerable room for improvement. Much effort is now being expended in signing open fires to provide not only radiant heat, but also convected heat derived from air which is heated by passage through ducts adjacent to the fire, the warm air is discharged into the room in which the fire is placed, or into other rooms. The probability that with systems of this kind the average household would obtain an efficiency of 30 per cent in place of 20 per cent with the ordinary open fire. During the past twenty-five years there has been great expansion in the use of electricity and a great increase in the efficiency of generation. The quantity of coal consumed annually during 1936-38 at electricity power stations was 14 million tons, this is more than twice as much as during the years 1921-23, and in 1943 the amount was about 23 million tons.

In 1921 the average quantity of coal consumed to produce one unit of electricity was 3.4 lb, whereas in 1938 it was only 1.4 lb. This means that the efficiency of generation was two and a half times as great in 1938 as in 1921. Even with this great improvement, the heat equivalent of the electricity generated was only about 20 per cent of the heat value of the coal burned under the boilers. Allowing for losses in transmission, the efficiency of generation and distribution in 1938 was about 18 per cent. Though the efficiency of generation is low the efficiency of utilization is usually high, for example, it may be taken as practically 100 per cent for the electric fire, this means an efficiency in relation to coal used at the generating station of 18 per cent. Before the War the efficiency of carbonization of coal in coke ovens and at gas works had reached the high average of roughly 75 per cent. Further improvement is probable but it clearly cannot be very great. From each ton of coal carbonized there is produced about 14 cwt of coke, 60-80 therms of gas, 10-15 lb of tar, and ammonia equivalent to about 1 lb of ammonium sulphate. At gas works, some of the coke is used to make water gas, heat the ovens, and generate steam and power, so that the quantity of coke available for sale is roughly 9 cwt per ton of coal. At coke ovens, a large proportion of the coal gas is used to heat the ovens. The coke is sold mainly for blast furnaces and other furnaces,

though some is sold for other industrial purposes and sometimes for domestic use. Much of the surplus gas is sold to gas works.

It is difficult to give an estimate for the efficiency of use of coke for the many and varied industrial purposes for which it is employed. Though it can be used with high efficiency in industrial boilers and for making producer gas, the efficiency with many furnaces is low. It is unlikely that the overall average is more than 50 per cent.

With coke for the open domestic fire with a grate suitable for burning this fuel, the efficiency under average conditions is roughly 25 per cent, and it could no doubt be increased to about 30 per cent, as with the open coal fire, if provision for heating by convection as well as radiation were included. In closed stoves and boilers (with hot-water radiators) of the usual domestic type, the efficiency of using coke is in the region of 50 per cent.

The efficiency of gas appliances in general is higher than with appliances using coal or coke. Modern gas fires have an efficiency of 40-50 per cent under average conditions.

In considering these figures for coke and gas, which are intended to represent overall average, not test, conditions, it should be remembered that in order properly to compare them with the figures for coal, they should be reduced to allow for the fact that heat is used and lost in making coke and gas from coal. If the efficiency of production is taken as 75 per cent, the efficiency in use should be multiplied by 0.75 to give the 'coal economy efficiency'.

Though much attention has been given to fuel economy by railway undertakings, the overall efficiency of use of coal for power for locomotives is necessarily low. Including shunting operations, the overall average is well below 10 per cent, and is probably not more than about 5 per cent.

Nature and Amount of Pollution

Of the various products of combustion or partial combustion, those which give rise to pollution of the atmosphere are mentioned in Table 2.

TABLE 2 POLLUTING SUBSTANCES FROM COAL AND PRODUCTS

(a) Solid	Particles of carbon causing black smoke and particles of mineral matter or ash carried forward with the gaseous products
(b) Liquid carbonaceous material	Fine particles of liquid tarry matter causing yellowish or brown smoke
(c) Unburned and partially burned gases	Gaseous hydrocarbons and carbon monoxide
(d) Sulphur oxides	Sulphur dioxide and some sulphur trioxide which with water forms sulphuric acid

It is not easy to assess the amounts of those forms of pollution produced by the various fuels with their different methods of use, and only approximate estimates can be given. It is worthy of note, however, that the methods of measuring amounts of pollution are steadily being improved. For example, during recent years considerable attention has been given at the Fuel Research Station of the Department of Scientific and Industrial Research to the measurement of the quantity of smoke emitted from domestic fires and industrial boilers using coal, and a satisfactory method has been devised. A detailed description of the method is being prepared for publication. It is based on measurements of the amount of light absorbed by the smoke-laden gases when a beam of light under standard conditions is passed through a layer of the gases, many difficulties had to be over-

come before a technique of sufficient accuracy and reliability was devised. As a result of this work, the figures now available are much more reliable than those previously obtained. Though the quantity of smoke emitted from the domestic fire is high, this latest investigation has shown that it is not so great as has often been stated.

In Table 3, approximate estimates are given, on the basis of the best available information, of the total amount of pollution produced annually from the use of coal in Great Britain under the conditions during the few years preceding the War.

TABLE 3 NATURE AND QUANTITY OF POLLUTION FROM COAL IN GREAT BRITAIN

Type and use of fuel	Quantity of coal (millions of tons per annum)	Pollution produced (millions of tons per annum)		
		Smoke	Ash	Sulphur dioxide
Coal				
Domestic grates	42	1.1	0.1	1.0
Electricity power stations	14	small	0.1	0.4
Railways	13	0.4	0.1	0.4
Collieries and various industrial uses	68	0.8	0.2	2.4
Coke and Gas				
Coke ovens and use of coke	20	small	small	0.6
Gas industry at gas works	19	small	small	0.1
in using gas		nil	nil	small
in using coke		nil	small	0.2
Total	176	2.3	0.5	5.0

From the figures in this table, the weight of tarry and carbonaceous matter in the smoke produced is 2-2½ million tons a year, or roughly 1½ per cent of the weight of the coal used. Approximately one half of this weight of smoke is derived from domestic grates, which use only about one quarter of the coal. The total pollution by oxides of sulphur is about 5 million tons a year, and the weight of the grit or ash discharged into the atmosphere is roughly 0.5 million tons. Not more than one fifth of the sulphur and grit arises from domestic appliances burning raw coal.

Reduction in Pollution

In the present state of knowledge and of development of fuel-burning appliances, it is not practicable entirely to prevent the pollution of the atmosphere through the use of coal and its products. It is practicable, however, to effect a considerable reduction in the amount of the pollution caused by smoke and grit, though it is much more difficult to reduce the amount of pollution from sulphurous gases. How can such an improvement be effected? There is no one method. Developments and changes in several directions are necessary.

In the first place, all practicable steps must be taken at the colliery to clean the coal before delivery to the consumer. A reduction in the adventitious mineral matter will reduce generally the solid matter to be removed when the coal or coke is burned, and the quantity of sulphurous gases discharged into the chimney. It is apparent also that as the best coal seams are gradually worked out the need for efficient cleaning will become greater.

The next important step is to ensure that the coal and its products, coke, gas and electricity, are used as efficiently as is economically practicable, and that the heat and power developed are not wasted. Efficient use of fuel can only be achieved as a result of skilled and intelligent operation, maintenance of fuel-using appliances in good condition, development of better

appliances, and the judicious application of insulating materials to reduce waste of heat. In Great Britain insufficient attention has been given to the training of fuel technologists and operators, and little attention has been given to the possibilities of insulating buildings with the object of conserving heat.

With large modern boiler installations equipped with mechanical stokers, little or no smoke need be produced, but installations of this kind with forced draught carry appreciable quantities of ash or grit into the chimney gases. Most of the grit can be removed from the chimney gases by the use of efficient grit-catchers such as have been installed at the largest electricity generating stations. There might well be extension of the application of this method to other boiler and furnace installations. At certain of the largest electricity power stations in thickly populated areas of Britain, coals containing not more than 1 per cent of sulphur are selected for firing the boiler furnaces. In addition, these power stations are equipped for the operation of processes which remove most of the oxides of sulphur from the chimney gases before discharge to the atmosphere. These processes of treatment to remove sulphurous gases, however, are not easily operated and are expensive, their cost on pre-war prices was 2-3 per ton of coal burnt. There is required some efficient but cheaper method of reducing the quantity of oxides of sulphur discharged, suitable not only for the largest but also for smaller boiler installations. This difficult problem is being studied, but there is no immediate solution in sight.

It has not been possible in the past, with the large numbers of hand-fired boilers at numerous industrial works, to avoid the emission of smoke, particularly for a time after stoking. As a result of extensive work by the Fuel Research Station during the last few years, equipment has been developed to replace the doors of marine and Lancashire boilers, whereby the emission of smoke can be practically eliminated. This equipment is simple to construct and very simple to operate. It provides at the right time and in the right way the extra air required to burn the smoke-volatile matter evolved from the fresh coal for the necessary period after stoking. This equipment is already in satisfactory use on many hundreds of marine boilers, and its value has been fully demonstrated, not only does it greatly reduce the amount of smoke, but also it assists in maintaining high efficiency in utilizing the heat value of the coal.

The domestic open fire produces more smoke per ton of coal burned than any other appliance in general use, it has already been mentioned that about one half of the smoke pollution arises from domestic appliances, though they consume less than one quarter of the total coal used, or less than one tenth of the coal burnt direct and not submitted to such processes as carbonization. Though the problem has been studied by many investigators, there is no immediate prospect of designing an open fire which will burn bituminous coal without producing a smoke. There are designs of open fire, however, which will bring about a reduction in the amount of smoke to about one half of that with the open fire of usual type, but they have not yet been tried in general use by the average householder. The emission of smoke during the early stages of burning after lighting seems to be unavoidable.

There is at present no method of reducing the amount of pollution by sulphurous gases from one ton of solid fuel burnt in domestic appliances.

whether the fuel is coal or coke, the proportion of sulphur in coke is roughly the same as in the coal from which it is made

Pollution by grit from the burning of coal and coke in domestic appliances is not easily prevented, though fortunately it is not very great

Substitution of gas for solid fuel would avoid pollution by smoke and grit and would reduce pollution by sulphurous gases to a negligible amount. The use of electricity in place of solid fuel avoids the production of smoke, but would not prevent pollution by grit and sulphurous gases unless the generating stations are equipped to remove the grit and sulphur from the chimney gases. In general, however, gas and electricity are too expensive for continuous heating in the average house, but they have advantages in many circumstances for short-period intermittent heating and for cooking

So far as domestic appliances are concerned it would seem that encouragement should be given to the use of coke, gas, and electricity in place of coal, so far as is economically practicable, if atmospheric pollution is to be greatly reduced. But the changes suggested could only take place gradually, if the demands for the various fuels and forms of energy are not to overstep the supply, and there must be a suitable balance if the resources of the different types of coal are to be used to the best advantage in the broad national interest. It should be pointed out that all the possibilities have not been covered. For example, the possibilities of communal central heating and district heating have not been discussed. It is hoped, however, that this broad review will serve to indicate the general lines along which progress can be made

COAL MINING IN GREAT BRITAIN

It would be difficult to exaggerate the importance of the Report of the Technical Advisory Committee on Coal Mining, presumably to be known as the Reid Report*. For almost a century, coal mining in Great Britain and its special aspects have been the subject of inquiry for royal commissions and departmental committees, and in the past few months much has been written on the reorganization of the industry. However, the Reid Report is without parallel. Seven distinguished mining engineers have examined the present lamentable position, and have set out in detail their proposals for the creation of a prosperous and efficient industry. Mr Reid and his colleagues have expressed their views with complete frankness, and have criticized impartially mine-owner, mining engineer and workman. If ever the term 'blue-print' could be applied to a document, then his report is a blue-print for the post-war mining industry in Britain.

The approach to the problem is historical, and part I includes a revealing comparison of the coal industry of Britain with those of the principal Continental nations. If two nations are mining coal under approximately similar natural conditions, then the output of coal per man-shift worked can be regarded as a measure of the efficiency of mining. Similarly, records of output per man-shift over several years will provide evidence of improvement or de-

terioration in the mining situation of a particular nation. In any comparison of statistics of output per man-shift careful account must be taken of the natural conditions under which the coal is worked. In the United States, mining conditions are greatly superior to those prevailing in Britain, and in Poland mining is carried on under the best natural conditions in Europe. However, in Holland and on the Ruhr, conditions are certainly no better than those of the British coalfields. Although useful conclusions can be drawn from the statistics of American mining, for a fair comparison we must turn to our Continental neighbours, and particularly to Holland and the Ruhr.

Those who desire an account of the vicissitudes of the British coal trade must refer to the report itself. The most significant period is that between the years 1927 and 1939, and it is sufficient here to say that, in spite of the introduction of several thousand mechanical coalcutters during the years 1913-27, output per man-shift showed little improvement from the 20.32 cwt of 1913 to the 20.62 cwt of 1927. Some progress was made in the years 1927-36, when the output increased by some 14 per cent to 23.54 cwt, a maximum for the period between the Wars. Small as the increase appears, it was achieved only as a result of intensive mechanization—the tonnage of coal mechanically cut increased from 58.5 to 142.2 million tons between 1927 and 1939, while the tonnage carried on face conveyors increased from 28 millions in 1928 to 134 millions in 1939. Taking Great Britain as a whole, the situation in the coal mines left little room for complacency.

In 1914 Britain was able to dominate the sea-borne coal trade of the world, and substantially retained this position until 1925, when Poland and Germany first assumed the position of serious competitors. To compare British and Continental progress the Committee has adopted as the basic year that in which each country attained the 1913 level of output per man-shift, and the following table is extracted from the report:

Country	Basic year	Output per man-shift		Percentage increase
		in basic year cwt	in 1936 cwt	
Poland	1927	23.44	36.20	54
Holland	1925	16.48	35.94	118
The Ruhr	1925	18.62	33.66	81
Britain	1927	20.62	23.54	14

Comparison with the United States would be unjustified, but it should be noted that the output per man-shift in the American bituminous mines amounted to 93.8 cwt in 1939.

Many reasons are advanced for this failure to attain, or even approach, Continental standards of output. The British industry has long lacked the financial resources to undertake major long-term improvements, and considering the low average profit per ton—7d. during the years 1929-38—this is not surprising. Conditions of mineral ownership have proved a disastrous handicap to the mines of Britain. Until 1942 the minerals were privately owned, and there remains a legacy of small and awkwardly shaped leaseholds, worked by an excessive number of mines, many of which are of low capacity. On the Continent the amalgamation of undertakings has resulted in the concentration of production in large well-equipped mines. In 1938 the Ruhr mines were of an average capacity of 778,000 tons per year,

* Ministry of Fuel and Power. Coal Mining. Report of the Technical Advisory Committee (Cmd 6610). Pp ix+150 (London: H.M. Stationery Office, 1945). 1s. net.

the twelve mines of Holland averaged 1,200,000 tons per annum. Britain, too, has mines of large capacity, but there are many small mines. In 1943, 90 per cent of the output came from 816 mines owned by 353 separate undertakings. The average yearly output per mine was 228,000 tons.

Relevant as are the above and other important conclusions, the recommendations on the details of practical mining form the backbone of the report. The hidden complexities of underground mining make the discussion of this section no easy task, and it is proposed to emphasize two fundamental operations—those of getting and transporting the coal. In Britain, most of the coal seams are worked by the 'longwall advancing system' of mining—some 74 per cent of the collieries are so laid out. Less popular, but giving good results under certain conditions, are the 'room and pillar' and 'longwall retreating' systems.

The room and pillar system was an early development in British mining practice. Here the seam is first divided into pillars of side 20–50 yd., by driving two sets of roads at right-angles. Developed a century ago in the coalfields of Northumberland and Durham, the method gives best results in shallow seams of a suitable thickness, say, 5–6 ft. When, however, attempts were made to work the deeper seams by room and pillar, many difficulties were encountered. Because of the great pressure on the pillars, there was an excessive 'crush' on the workings, the pillars tended to disintegrate, and the roads to close in. Pillar extraction, a normal and safe operation at shallow depth, was made difficult and often impossible. The system also proved unsuited to the working of thin seams, and there was thus a gradual change over to the 'longwall' system of working. However, the room and pillar system is almost universal in the United States—with the important difference that the workings are highly mechanized. Since 1941, American methods of production have been studied by British engineers, and it is considered that a proportion of the British output could, in future, be won from mechanized room and pillar workings. Experimental lay-outs have been equipped on American lines, and the results are sufficiently encouraging to suggest that the system will find a useful, if limited, application in Britain. The outstanding feature of American methods is that a very high proportion of the workers is engaged on actual coal production, and this accounts in some measure for the high output per man-shift.

Natural conditions in Britain have proved most suited to the 'longwall advancing' system. In its modern application a straight wall of coal or 'face', say, 200 yd long, is prepared. Two mechanical conveyors are laid along the face, each feeding on to a main conveyor in the centre and at right-angles to the face. The coal worked is filled on to the conveyors, and loaded on to 'tubs' (small wagons) at a loading point at the end of the main conveyor. An average rate of advance is 5 ft per day—that is, a block of coal 200 yd long, of height equal to the thickness of the seam, and 5 ft in depth is removed. The whole of the equipment and supports must thus be advanced 5 ft per day. More important, the empty space, or goaf, left behind the advancing face, must be partially packed with debris, and roads must be prepared and maintained through the goaf. This is unproductive work, inherent in this system of mining, and absorbs the labour of substantial numbers of underground workmen. Nevertheless,

the method has many technical advantages, and will long find an important place in British mining practice.

The 'longwall retreating' system combines, in some measure, the advantages of the other two systems. Roads, known as headings, are driven in the seam to a pre-determined boundary to form a pillar, say, 300 yd long and 100 yd wide. This pillar is then extracted back towards the main road from which the headings were started. So far, the system has not been widely used in Britain, but there are reasons to believe that, with the use of modern machinery for intensive development, longwall retreating could well be applied in many British mines, with a consequent reduction in the proportion of unproductive labour.

The Committee thus recommends a complete reconsideration of established mining methods. Mechanized room and pillar should be applied where conditions are sufficiently favourable. Since this will by no means be generally applicable, consideration should be given to the use of longwall retreating methods, and finally the longwall advancing system should be applied to those circumstances in which the other two systems are unsuitable.

In the nineteenth century, practically the whole output of British mines was won by means of the hand pick. Now some 80 per cent of the coal is under cut by mechanical coalcutters. After undercutting holes are bored in the coal, and these charged with explosive and fired, so leaving the coal in a suitable condition for hand filling by means of a shovel. In 1939, on every working day, nearly 1,000,000 tons of coal came from the shovels of the British miners. If the operation of loading could be mechanized, there are clearly possibilities of a tremendous saving in labour. For room and pillar work there are excellent machines of British and American manufacture, used for lifting the broken coal from the floor to a conveyor or tub. Loading machines of a different type are required for longwall faces, and the design of a suitable machine is a difficult technical problem. Nevertheless, British manufacturers have produced loading machines of distinct promise, and these are in use in experimental installations. That the Committee attaches the greatest importance to their further application is clear from the statement "the development in mining technique must be directed first and foremost, to a reduction in, and ultimately to the practical elimination of hand loading."

A mechanical loader, however efficient, has one important limitation—a coalcutter must first be used to prepare the coal for loading, and the use of explosives may also be necessary. The Committee envisages the use of machinery which will be capable of simultaneously cutting and loading the coal. At least one machine of this type has been used, and the prototypes of other machines are nearing completion.

Traditional haulage practice provokes the keenest criticism. In British mines there is apparently serious wastage of labour in hauling the coal from the working face to the shaft bottom. One haulage worker is required for every 50 tons of coal produced in the United States, for every 20–25 tons in Holland, and for every 5 tons in Britain. There is evidently much to be learned from a study of American and Continental haulage methods.

Wire-rope haulage is standard practice in British coal mines. Conveyors may be used to bring the coal to a loading station, and from there the tub

SCIENCE AND ART AT THE
ROYAL ACADEMY, 1945

By DR A. T. HOPWOOD

British Museum (Natural History)

hauled to the shaft by means of wire ropes driven stationary engines. In an old or badly laid-out mine, the coal may be hauled by a succession of such haulages, each haulage requiring its complement of haulage engines. Conveyors could be much more widely used to transport the coal to well laid-out loading stations, so eliminating the wasteful use of labour and subsidiary haulage systems.

In the United States and on the Continent, locomotives are widely used underground. But the use of locomotives requires roads which are level, or nearly so, and the present lay-out of most British mines is such as to prohibit their widespread installation. Roads have been driven in the coal seams, but in general the gradients are unsuited to the use of locomotives. Continental seams are more inclined, and the practice there is to drive level roads through solid strata, these serving as the main arteries of the mine along which the locomotives operate. The organization for locomotive haulage will require the preparation of great lengths of graded roadways, and if the full advantages of locomotive haulage are to be realized, mine cars of a high capacity will be required. The capacities of the tubs used in British mines range from 3 to 28 cwt—the average is probably 12 cwt. For use with locomotives, mine cars must be required each capable of holding several tons of coal.

For details of mining practice are passed over in this unique survey. Standards of mine lighting, the Committee considers, could be materially improved. The advantage to production, safety and health of illumination at the coal face is now provided by portable self-contained lamps, but it is recommended that power-fed lighting should be installed at the coal face. Recent research has shown that the cathode discharge lamp may well prove a more efficient and efficient means of illuminating underground workings.

In an interesting paragraph the appearance of very premises is discussed. It is true that in the past little or no attention has been paid to this point, and "disorder and dilapidation" so often associated with colliery premises must have its psychological effects on the workmen and adversely influence public opinion on the state of the industry. An architect should be consulted when plans are being prepared for new mine or for remodelling an old mine.

It is apparent that reform on the lines suggested in the Reid Report will require major changes in the organization of the coal-mining industry in Britain, and this is discussed under "Conditions of Work". There will need to be amalgamation of many of the smaller undertakings to form productive units of a much greater capacity, and many existing mines will become redundant. There is a note of warning to the workmen and their leaders that if living wage-levels are to be maintained, then there must be a considerable increase in output per man, and that a rebuilt industry may have to disperse with substantial numbers of unskilled workers. In the past, the layman may have formed the view that Britain's coal problem was that of utilizing her abundant resources of coal. This report puts first things first—the fundamental problem is that of mining the coal efficiently, and any plans for the utilization of coal depend primarily on the availability of large quantities of cheap coal. Finally, those with no special knowledge will read the report without difficulty, assisted by a most useful glossary of mining terms.

H. HARTLEY

IT is a commonplace of criticism that a painting is not only the result of the artist's competence and temperament, but also of his country and period. Thus a Titian could arise nowhere else than in Italy, neither could a Vermeer be found elsewhere than in the Low Countries. The former reflects the warm colouring of the south, and the patronage of opulent, semi-pagan princes and prelates, whereas the latter echoes the cooler skies of the north, and the solid worth of prosperous burgherdom. Some years ago, Frank Rutter, following an earlier suggestion by Sir Michael Sadler, pointed out that, from the commencement of the present century, art in the hands of its more advanced exponents became more and more violent until, in the last years before 1914, men like Kandinsky and Wyndham Lewis were painting pictures of which the themes were connected in some way or another with war.

This prophetic aspect of the psychology of art can best be realized after study of pictures extending over some years, and it may be that the six war-time exhibitions of the Royal Academy do not constitute a long enough series, but one point in particular has attracted my attention, and to add emphasis I propose to illustrate it by reference to pictures painted by academicians, or associates, that is, to the work of men who, traditionally, are not included among the most advanced members of the craft.

Consider, first of all, Algernon Newton, who in 1942 exhibited bright and sunny scenes of London's canals. As the years have passed, his sunshine has gradually become less bright and more gloomy until in the present exhibition, even in pictures of the countryside (Nos 348, 352, 363), it has achieved that blackish quality which gleams out fitfully before the storm, and in the town has become so dramatic as almost to be theatrical (No 68). Sir Alfred Munnings is another whose sunshine is sometimes gloomy (No 140) and whose skies are often sad (Nos 136, 140). On the other hand, Edward Wadsworth has two longshore scenes (Nos 711, 715) of a type sufficiently advanced to satisfy any but the most fervid worshipper of 'isms'. His colours are strong and the first impression is one of stimulus akin to that of a cocktail, but the stimulus soon passes and a vague feeling of malaise, as it were a sense of the malevolence of the inanimate, remains. These might be thought a curious sequence and combination to occur as a long and hard-fought war drew slowly to a victorious close, but they are not unintelligible when considered in relation to the gradual realization of the thorny problems which would beset the peace-makers.

A painter's problems are exemplified by the work of James Fitton. "Woman Reading" (No 61) and "Country Interior" (No 602) belong to a group of works which he has shown during the last few years, and which are chiefly exercises in the management of red, perhaps the most difficult of all colours except purple, of which more later. These two canvases show, as they were bound to do, how the primary colour, red, tends towards its secondaries (orange and purple) and the secondaries towards the tertiaries, or, if this theory of colour be considered too old-

fashioned, they may be regarded as essays in the harmony of orange and red, and the employment of suitable contrasts and discords. So far as one may judge from the background of "Reclining Figure" (No 678), the artist himself would prefer the latter theory.

Purple in its lighter tones has ruined many acres of canvas in pictures of the 'sheep-among-the-heather' type, but in its deeper tones it is rich and magnificent, though still dangerous. The State portraits by Gerald Kelly (Gallery III) are noteworthy for the skill with which the imperial purple is rendered, a skill which cannot be fully appreciated without the realization that instead of the usual foils of green and brown these great masses of colour are displayed in a setting of parian coolness, and yet never for one stroke of the brush does the colour get out of control. True, the gold embroideries are a help in achieving this end, but they are by no means the whole of the story.

On an adjacent wall in the same gallery, "Dr Clive Forster-Cooper, F.R.S., Director of the Natural History Museum", by Meredith Frampton (No 165), blends complete mastery of the painter's materials with consummate draughtsmanship. For the former, reference may be made to the contrast in texture between the surfaces of the dog's jaw in the left lower corner and of the series of plaster models of some upper molars of primitive mammals scattered over the table in seeming disarray, while the drawing is summed up by the open book in which is epitomized a whole course of perspective and line. Another excellent portrait hangs in the far corner of the same room. It is L. Campbell Taylor's portrait of "The Rt Hon the Lord Macmillan, G.C.V.O., LL.D." (No 205), whose voluminous black robes, set against deep green curtains, are relieved by an edging of silver lace. A more intimate type of portraiture is "Professor A. G. Tansley, F.R.S.", by W. G. de Glehn (No 302), in which the sitter is shown, pipe in hand, in the quiet of a book-lined study.

Of the war pictures, "Torpedoing of the *Turpitz* by Midget Submarines" by Richard Eulich (No 569) gave me most pleasure. No minefields, even in the clear waters of the Norwegian fiords, were ever so visible as these—never was there such a whelk as crawls on the bottom of this sea, yet all have their place in this picture, and no one would wish them away. Whether or not we have here an echo of the Futurist 'plastic interpenetration of matter' I neither know nor care, drawing, design and painting are all good, and the picture pleases me.

As usual, the sculpture is a very mixed lot. To the zoologist the more or less naturalistic works such as "Tarka", by P. E. Norman (No 1248), "Leopard" by Hermon Cawthra (No 1281), and "Rhesus Monkey" by Josephine Hunt are the most attractive, and he will probably find that most of the horses are better than usual. On the other side of the account he will put "Long-nosed Hedgehog" (No 1293), if only on account of the unpleasant colour of the marble, as well as the lumpy "Messenger" (No 1359) and the brutish "Infant Dionysus". One cannot complain of the stone in which the two last are worked, it successfully conceals the sculptures.

The architectural exhibits are fewer than last year. In the main they are pleasantly uninspired, but two of them call for particular comment. "Durham City Replanned", by Thomas Sharp (No 1201), is ambiguous. If the new buildings in the foreground are really meant to be of the boot-box style, then

the incongruity between them and the castle cathedral in the background is so violent as almost to be bad manners and not merely bad art, if, the other hand, they are mere symbols to indicate where new building will be necessary, one must defer judgment until the designs for the actual buildings have been produced. The other doubt case is Sir Giles Gilbert Scott's design for the Coventry Cathedral, of which the interior does strike one as suitable for an ecclesiastical building, neither does it appear to be in keeping with the exterior.

Taking the exhibition as a whole, it is lively, varied, and of good quality. To expect it to indicate a definite trend in any particular direction, or favour of any one school, is unreasonable, since to do so would be to upset the general balance of the whole, but any visitor with some knowledge of the development of European art during the past 100 years will say of the Royal Academy, as was said of another body on an earlier occasion, "E pu muove".

OBITUARY

Sir Napier Shaw, F.R.S.

SIR NAPIER SHAW, whose death occurred on May 23, was born on March 4, 1854, in Birmingham, son of Charles Thomas Shaw, manufacturing engineer and jeweller. He was the sixth child of a family of eight, four brothers and four sisters. He married in 1885 Sarah Harland, lecturer in mathematics at Newnham College and daughter of Thomas Harland of Salford.

Shaw received his school education at King Edward's School in his native city, and throughout his long life retained a lively interest in his old school, serving on its governing body for many years. In 1872 he won a scholarship to Emmanuel College, Cambridge, and went into residence with the avowed intention, as he often told his friends, of entering the Indian Civil Service. He read mathematics, coached under Routh, and was 16th Wrangler in the Tripos of 1876. Later in the same year he obtained a class in the Natural Sciences Tripos, with distinction in physics. In the following year the College elected him to a fellowship and that seems to have been the end of the suggestion to embark on an administrative career in India. Cambridge was to be his home for the next twenty-two years apart from a short time spent in Berlin, working under Helmholtz.

Shaw soon made his mark in college and university. Lord Rayleigh appointed him demonstrator of the Cavendish Laboratory, jointly with R. T. G. Brook, and to that combination we owe the "Practical Physics" which became a standard text-book for schools and colleges up and down the country. Whatever experimental work formed part of the physics course. He gave up the demonstratorship in 1880 to become University lecturer in experimental physics and in 1898 was appointed an assistant director of the Cavendish. His early scientific work was a series of lines that have little connexion with what we now call his life work. His first published paper (*Cambridge Phil. Soc.*, 1879) dealt with experiments with mercury electrodes, and was followed a few years later by one in the *Philosophical Magazine* on the atomic weights of silver and copper. Miscellaneous papers on various subjects followed. Ventilation

subject in which he took an early interest which persisted throughout his life. In the course of his career he was asked to advise on the ventilation of many public buildings, among them the House of Commons, the Stock Exchange and the Metropolitan or-law schools.

The first contact Shaw made with official meteorology came in the form of a request from the Meteorological Council to prepare reports on the performance of evaporimeters in current use and on the more general question of hygrometric methods. The latter report was published in the *Philosophical Transactions* in 1888 and was the first contribution from Shaw's pen to the Royal Society's publications. His reputation in the scientific world was advancing rapidly and was recognized in 1891 by election to a fellowship of the Royal Society. He was a frequent attendant at the meetings of the British Association. In his later years he was to act as president of Section A in 1908 and of Section L in 1919.

While at Cambridge, Shaw took a very active part in the affairs of college and university. At Emmanuel he held the offices of steward, tutor and senior tutor (90-99), and a long list of pupils has to thank him for his kindly guidance and wise advice. Two important new movements in the University organization stand to his credit. In 1892 he was the prime mover in founding a group of colleges to combine their scholarship examinations and thus abate the competition of the most promising candidates which had become a source of embarrassment to tutors, school-masters and candidates alike. His second opportunity came towards the end of his time at Cambridge. As tutor, Shaw had repeatedly come up against the difficulty of pupils experienced in getting a start in life after leaving their degrees. Apart from an agency which confined itself to scholastic appointments, there was no machinery for helping them. There was an obvious opportunity for beneficial work for an office or agency that would make it its business to find out what openings were available in commerce, industry, Government service, and on the other hand would arm itself as fully as possible of the qualifications and competence of young graduates seeking employment. A certain amount of crusading to induce prospective employers to take graduates lacking *ad hoc* business experience into their service was also a missing field of activity. Shaw set out to enlist support for a scheme on such lines both within and outside the University. On the commercial side he received valuable assistance from the late Nathaniel Brown, a member of the London County Council, whose wide business connexions enabled him to suggest many useful lines of approach. As a result of these efforts, a Cambridge Appointments Association was started in 1899. It was eventually formally incorporated as part of the official organization of the University under the name of the Cambridge University Appointments Board.

Shaw left Cambridge towards the end of 1899 to become secretary of the Meteorological Council, which was about to become vacant through the retirement of R. S. Scott. The change involved some personal sacrifice, but his early work for the Council aroused his interest, and in 1897 the Royal Society had appointed him a member of the Council. In Shaw took charge, the Meteorological Office was at a low ebb. Strachey and Buchan, the two most active members of the Council, were advanced in years, and the drive which they and men of the

calibre of Stokes and Galton had put into the scientific work had spent itself. The staff consisted largely of middle-aged and elderly men who had been attracted to the subject as youngsters, but now found themselves carrying on their routine on salaries that were certainly not generous and with no superannuation to look forward to. Nevertheless, Shaw soon gained the unstinted loyalty of his staff and rekindled their interest. One of his first administrative tasks was to bring into operation a superannuation scheme for the clerical staff, even though it had to comply with the Treasury's instruction that if the Council felt it must make some provision for staff who had long and faithfully served them, it, like other employers, should see what it could do from its available resources. Recruitment of new staff also required much thought. Great care was exercised in the selection of junior clerks as vacancies arose, and gradually new posts were created that could be offered to graduates. By the time Shaw left the Office it had a considerable graduate staff.

In 1905 Shaw secured an overhaul of the constitution of the Meteorological Office. The Council, which had been responsible to the Royal Society, was replaced by a committee directly responsible to the Treasury, with himself as chairman of committee and director of the Office. The design of the new premises in Exhibition Road, South Kensington, to which the Office moved in 1910, took up much time during the following five years. It must have been a source of regret to Shaw that the building on which he had lavished so much thought and embellished at some personal expense should so soon prove inadequate to house all the activities of the Office. At the time of its design the top floor, to be occupied temporarily by the administrative staff of the Science Museum, seemed to offer ample space for expansion.

Under Shaw's vigorous guidance and the pressure of events, the activities of the Office increased rapidly. On the climatological side the network of voluntary stations that supplied reports to the Registrar-General and also those associated with the Royal and the Scottish Meteorological Societies came under the control of the Office. Summaries for all stations were included in the *Monthly Weather Report*, which thus became an index of the climatological information available in Britain month by month. Later on, but not until 1919, the British Rainfall Organization was absorbed. Kew and Eskdalemuir Observatories were transferred and with them came responsibilities for terrestrial magnetism, atmospheric electricity and seismology. The demands of aviation for meteorological help were beginning to press. With R. T. Glazebrook (the close co-operation, started in the early days at the Cavendish, continued up to the time of Glazebrook's death) Shaw started the Advisory Committee for Aeronautics, which brought much grist to the mill. With J. S. Owens's assistance, the work of the Committee on Atmospheric Pollution was got going. In the sphere of international meteorology Shaw also became a figure of importance. His election to the International Meteorological Committee on becoming head of the Office was little more than a matter of form, but in 1906 he succeeded Mascart as president of the Committee, an office he was to hold until 1923.

Despite the pressure of administrative work and of calls incidental to his position, Shaw found time for authorship and for making his contribution to the science of meteorology. In 1911 appeared the first edition of "Forecasting Weather", in which he

set himself the task of bringing together the physical laboratory and the daily weather. His contributions in the form of papers and articles covered most aspects of the subject and are too numerous for individual mention here, but we may perhaps single out "The Life History of Surface Air Currents", in which the method of using synoptic charts to construct trajectories and so trace different air supplies to their origins was developed. It led up to the modern ideas of air-mass analysis which have yielded such valuable results, both theoretical and practical, through the labours of the Norwegian school of meteorologists.

Shaw's influence went far beyond the immediate output of his pen. He was a great advocate of a rational system of units, and never tired of ventilating the subject. If some of his efforts in this direction, such as the use of the absolute or tercentesimal scale of temperature which he introduced into the "Observatories' Year Book" and followed in his later scientific writings, have found few imitators, he had the satisfaction of seeing the millibar, first advocated by V. Bjerknes, find wide acceptance. After Shaw had introduced it in the British *Daily Weather Report* in the issue of May 1, 1914, other services followed suit, and its use is now firmly established in the international exchange of synoptic data and in upper air work.

The need for investigating meteorological problems on a world-wide basis led to another of his successful crusading efforts. Backed by the late Sir Norman Lockyer, he induced the International Committee to form a "Réseau Mondial Commission", and what is perhaps more important, he managed to arrange for the Meteorological Office to act for the Commission and collect monthly summaries on a basis of two stations to each square of 10° of latitude and longitude and publish them in annual volumes, thus providing raw material for investigations on seasonal forecasting and kindred problems by many workers. About the turn of the century, when Shaw took charge of official meteorology in Britain, the investigation of the upper atmosphere by means of kites and balloons was opening up a new field of research and turning meteorology from a two-dimensional into a three-dimensional science. Shaw saw to it that Britain played its part in the new field. Much of his work was done in association with the late W. H. Dines, whose home, transferred successively from Oxshott to Pyrton Hill and thence to Benson, became more or less a branch establishment of the Office. Not least among Shaw's gifts must be reckoned his power to interest others in his work. To that we owe the contributions of men like C. J. P. Cave and P. Y. Alexander to upper air research.

All these activities were rudely interrupted by the outbreak of war in 1914. It was not long before the Fighting Services felt the need for meteorological help, and new and unexpected demands were made on an Office struggling to maintain its essential routine. A greatly increased staff had to be recruited and hurriedly trained, and that raised a difficulty of its own. There was no suitable text-book on which to base the training. The writing of a comprehensive manual of meteorology had long been one of Shaw's ambitions and from time to time he had discussed ways and means with the Committee and found them sympathetic, but leisure for starting the work had been lacking. The desire had now become an urgent need, which the Committee met by suggesting that

Sir Henry Lyons should take over the day-to-day administration, as acting director, thus setting Shaw free for the labours of authorship. The arrangement came into operation early in 1918, the Treasury having given its consent and marked its approval by appointing Shaw scientific adviser to H. Government on meteorology. To meet the more urgent demands work was started on Part 4 of the full scheme, which presently appeared, though not until after the cease fire had sounded, under the sub-title "The Relation of Wind to the Distribution of Atmospheric Pressure". Lyons retired from acting directorship soon after hostilities ceased and Shaw had to resume full control up to the time of his own retirement in September 1920, and so fell to his lot to carry through the transfer of the Office to the Air Ministry. In anticipation of his earlier retirement he had consented to become president of the Royal Meteorological Society for the two years 1919 and 1920, a post he had consistently refused when asked to serve during the earlier years of his directorship.

Shaw left the Meteorological Office to become its first professor of meteorology in the Imperial College of Science and Technology. It had always been his ardent wish that universities in Britain should take part in the teaching and development of meteorology and for some years he had been reader in meteorology in the University of London. The new post was considerably further in meeting his desire. True, it was not a full professorial chair, but it was at least a beginning. He held it until 1924, when he succeeded by Sir Gilbert Walker.

His teaching post was not the only call on his time. The Atmospheric Pollution Committee pressed him to continue to act as its chairman, and the Ministry of Agriculture invited him to preside over a committee appointed to foster agricultural meteorology. Even more exacting were the calls of international work. Meteorologists were among the first to get together again after the War of 1914-18. An open conference was held in Paris in the autumn of 1919, and Shaw was the obvious person to act as president. The conference reappointed a permanent committee with Shaw as president. He was re-elected in 1921 despite the fact that he was no longer director of a national service. His release from the office did not come until 1923. The Upper Air Commission also insisted on Shaw becoming its president, that offered further opportunities for impressing ideas—or should it be ideals?—on meteorology. Among the tasks which the Commission sets itself is the publication of data collected on a world basis on 'international days'. Before the War of 1914 the issue of this publication was in German hands. It was decided to resume operations by printing information available for 1923. Shaw presented it in a *de luxe* style. He intended his volume to serve as a model of what the Commission should aim at. Unfortunately, *éditions de luxe* are expensive. The Commission was able to print the data for 1923 in a somewhat similar form, but for subsequent years Prof. Hergesell, who again became president when the Commission met in Leipzig in 1927, fell back on the expedient of setting it out in code.

Shaw's work for the Upper Air Commission gave us the tephigram, a diagram for plotting data from balloon ascents in which entropy and temperature are used as co-ordinates. It lends itself to rapid plotting, and the resulting graph, considered in relation to the grid, shows up regions of pressure

tial instability very clearly. The form is now in regular use in the forecast service of Great Britain and other countries.

During the years that followed his retirement from the Meteorological Office, the newly formed International Union of Geodesy and Geophysics also made calls on Shaw's time. He became president of its Meteorological Section and acted in that capacity at the meetings in Rome (1921), Madrid (1924), Prague (1927) and Stockholm (1930).

When he retired from his professorship, what Shaw himself regarded as one of his most important tasks still lay before him, the completion of the "Manual". A serious illness in 1928 threatened to prevent the fulfilment of his hopes but he lived to see all four volumes completed. The last, a revised and enlarged edition of Part 4, now with the more concise title "Meteorological Calculus. Pressure and Wind", was signed for press on March 31, 1931, when Shaw had entered on his seventy-eighth year. Even then his capacity for writing was not exhausted. In 1933 he gave us "The Drama of Weather", a

fascinating book addressed to the general reader rather than the specialist. Three years later a revised edition of Vol 2 of the "Manual", bringing up to date the statistical information, was called for. He signed the preface to this on March 4, the eighty-second anniversary of his birth. Two years later, when a second edition of the "Drama" was required, he still had the vitality to make considerable additions.

Shaw was the recipient of many honours. He was knighted in 1915. Honorary degrees were conferred on him by the Universities of Aberdeen, Edinburgh, Athens, Dublin, Harvard and Manchester, and foreign membership by the Academies of Boston, Oslo, Rome and Stockholm. His gold medals included the Symons Medal of the Royal Meteorological Society (1910), the Buys Ballot Medal of the Dutch Royal Academy (1923) and a Royal Medal of the Royal Society (1923). He was an honorary fellow of the Royal Society of Edinburgh and of Emmanuel College, Cambridge. He was made Commander of the Order San Tiago da Espada (Portugal) in 1921.

R G K LEMPFERT

NEWS and VIEWS

Prof C Leonard Huskins

PROF C LEONARD HUSKINS, professor of genetics in McGill University, has been appointed professor of botany in the University of Wisconsin, in succession to Prof C E Allen, who is retiring. Prof Huskins' appointment takes effect from September 1. Prof Huskins was born in Walsall, England, in 1897, he went to Canada with his parents at the age of ten, and was educated at Red Deer, Alberta, and the University of Alberta, Edmonton, obtaining the degrees B Sc Agr in 1923 and M Sc in 1925. As Overseas Scholar of the Royal Commission for the Exhibition of 1851, he went to the University of London (King's College) during 1925-27, when he obtained a Ph D in botany. He was then research cytologist at the John Innes Horticultural Institute until 1930. In 1930 he was appointed associate professor of botany in McGill University. Then he established the Department of Genetics and was appointed professor of genetics in 1934. Prof Huskins has worked chiefly on the cytogenetics of cereals and liliaceous plants, the origin of species through polyploidy and on chromosome structure. At the University of Wisconsin his teaching and research will be devoted mainly to cytology.

Academy of Sciences of the U S S R Anniversary Commemoration

THE Academy of Sciences of the U S S R celebrates this year the 220th anniversary of its foundation by Peter the Great. At first the Academy was not only a learned society and centre of research, but also a university or public school where Russian youths were trained for various vocations and even crafts. The first scientific debate was held at the Academy in November 1725, when Newton's theorem on the spheroidal shape of the earth was discussed. In 1745, that is, twenty years after its foundation, Mikhail Lomonosov, famous chemist, geographer and poet, whose work had an important bearing on modern science in most varied fields of knowledge, was

elected to the Academy, where he founded a chemical laboratory. Peter the Great gave the Academy his private library, which formed the basis of the present library, now numbering about ten million volumes. The Academy also received Peter's famous "Kunst-kammer" with its great collection of fossils, mineralogical specimens and curios, which in time developed into the present geological, zoological, mineralogical and palaeontological museums. Almost on his death-bed Peter drafted a plan for an expedition to Kamchatka to discover whether Asia and America were connected by land. The exploration of Russia and the study of its mineral, plant and animal resources played a large part in the scientific activities of the Academy at its inception. Its geographical department produced a series of maps of Russia and Siberia.

To commemorate the anniversary of its foundation, the Academy held a special session during May 25-June 6. The programme included meetings in Moscow and Leningrad, visits to various research institutes, and sight-seeing expeditions. More than a thousand guests from at home and abroad were invited. The session was opened by the President of the Academy, Vladimir Komarov, who spoke on the growing importance of the Academy. Papers were read on the history of Russian science in various fields and on the part played by Russian scientific workers during the War, and the contribution which they hope to make towards rebuilding the world. The geographical and geological expeditions of the Academy were the subject of special reports, as was the work of Russian men of science in the fields of organic chemistry, aerodynamics, mechanics and physiology. The problems now under investigation in the twelve departments of the Academy were discussed. The programme provided for a visit to the site of the famous Pulkovo Observatory, which was destroyed by the Germans. There was an exhibition of standard works printed by the Academy or written by its professors and published elsewhere. Some interesting manuscripts and other documents illustrating the history of the Academy were reprinted for the anniversary.

Journal of Meteorology

ONE result of the War has been such an increase in the number of meteorologists in the United States that the American Meteorological Society has decided that the moment has arrived when a financial success can be made in America of what is described as "a technical journal of the highest caliber in the field of meteorology". The recently reorganized Society has recognized the need to serve both the professional and amateur meteorologist, and it is for the professional that the new journal under the title *The Journal of Meteorology* is mainly intended (American Meteorological Society, Milton 86, Mass.) It is to be a quarterly journal eventually, but owing to the difficulty of starting a new publication, especially in war-time, it was considered best to have only two issues in the first volume, dated 1944, and the copy of the first issue that we have received, dated September 1944, is accordingly described as vol. 1, Nos. 1 and 2. The journal is edited by Prof. Victor P. Starr, of the University of Chicago, and there are four associate editors, among whom is J. Bjerknes. The print is larger than that usually used in scientific journals at the present time, and both it and the diagrams are very clear, the paper cover is a bright yellowish-orange. There are four articles, dealing respectively with the theory of the genesis and movement of cyclones, the determination of normal regions of atmospheric heating and cooling, the changes of temperature during the formation and dissipation of stratus cloud on the Californian coast, and lastly, the relationship between the major changes in the paths of tropical storms and the upper wind-field. The journal has certainly made a very promising start, and we wish its editors every success.

Planning Regional Electricity

IN devoting its April issue to "Electricity in its Regional Setting" the *Architectural Review* has rendered a real public service. The review of the whole situation, including recent public inquiries at Durham and Lincoln, the work of the Electricity Commissioners, the Central Electricity Board and the newly formed North of Scotland Hydro-Electric Board, which the Association for Planning and Regional Reconstruction has produced for this issue is admirably presented and is not only of particular interest to the scientific worker but also to every citizen concerned with the development of national resources and the preservation of amenities. Taken as a whole, it explores the shallowness of the pretensions of hydro-electric schemes for the Highlands to have anything in common with the ideas and procedure of the Tennessee Valley Authority, and it is strong indictment of the Government's persistent refusal to deal with the question of a real central planning authority.

The survey puts the case for a plan for electricity in its wider regional setting from various points of view and shows how profoundly unsatisfactory is the present situation. There has been no published survey, on the national and on the regional scale, of existing facilities and resources, and there is no evidence that the development of the electricity "Grid" has been anything but piecemeal. No published plan has seriously attempted to link together the ascertained physical facts—mineral resources, rainfall, communications and transport, population, consumption, etc.—with the proposed extensions and development. The Tummel scheme, as Lord Malcolm Douglas-Hamilton shows, is a glaring example of this omission

Again, apart from the national and regional aspects, the siting of both thermal and hydro-electric power stations, their design and appearance has consistently been unintelligent, while finally, the preparation of such schemes in secret and their issue by instalments amounts almost to a deliberate misleading of the public.

Among the articles included in this number is a severe but reasoned criticism of the Central Electricity Board by Mr. Hugh Quigley which shows convincingly the dangers as well as the opportunities inherent in its structure and its lamentable failure to insist on a national approach, to foster research and development and to elaborate a national plan to which all other interests must be subservient. Those by Lord Forrester on "Industry and its Environment", by Dr. E. F. Armstrong on "Electrochemistry and Metallurgy", by Dr. R. Gilmour on "Electrotechnical Industry and the Highlands", by the late Prof. F. C. Bailey on "Small Hydro-electric Stations", by Prof. C. H. J. Daysh on "Siting of Industry—The Regional Approach", by J. A. Dempster on "The Design of Industrial Buildings" and by G. A. Jellicoe on "Power Stations in the Landscape" and the anonymous article on "The Load Factor" are of most interest to scientific workers as such, but the whole number is a sombre indictment of the present position and of Government negligence, as well as of the Central Electricity Board or the Electricity Commissioners, which is the more impressive because of the restraint with which the evidence is presented.

Atomic Particles from the Sun

OBSERVATIONS during the solar cycle just completed have shown that a close correlation exists between solar flares—transitory patches of enhanced emission visible in hydrogen and calcium light near spots on the solar disk—and terrestrial magnetic storms. Great magnetic storms and auroral displays tend to occur about a day after the appearance of a brilliant flare, and it has been suggested that they are due to charged particles emitted from the sun simultaneously with the visible radiation. If the geometrical conditions are suitable, it is suggested, these particles begin to reach the earth 20–26 hours later, and cause disturbances of the magnetic traces which may last for a day or more. Nearly twenty years ago, Milne gave theoretical reasons for believing that atomic particles might be ejected from the sun at a speed of about 1,600 km/sec, which corresponds to a time of travel of 26 hours. Soon afterwards, Chapman suggested that a comparison should be made between solar spectra at times of magnetic quiet and of magnetic disturbance. The annual survey of the year's work at Mt. Wilson (Adams, *Pub. Ast. Soc. Pacif.*, 56, 213, 1944) now states that solar spectrograms taken in the ultra-violet region during magnetic storms give some indication of two very shallow absorption bands beginning near the centre of the lines H and K and extending about 12 Å towards shorter wave-lengths. Their maximum depth is only 1 per cent of the background continuum. Maximum velocities of the order of 1,000 km/sec and mean velocities of about 600 km/sec are indicated. Control spectrograms taken during magnetic calm show no such absorption. This is the first direct observational evidence of the presence in interplanetary space of calcium ions approaching the earth from the sun at speeds comparable with those predicted both theoretically and by inference from geophysical observations.

Phenomenology and Physics

AN article under this title by H. Margenau appears in the current issue of *Philosophy and Phenomenological Research*. It sets out to expound to the student of physics the main concepts of Husserl and his school, in addition, some consideration is given to the point of view which a physicist interested in methodology might take about the doctrines of phenomenology. At the outset the author is at pains to stress the special meaning attached to the word 'phenomenology'. Far from representing something superficial (that is, associated with 'mere' phenomena) this discipline is the most all-embracing matrix in which, so to say, all experience can be embedded. The paper is in three sections: (1) general thesis of phenomenology, (2) epistemology of physics, (3) the notion of certainty in phenomenology. It seems likely that, of the two types of facts recognized by Husserl, contingent and necessary, the latter are being gradually worn down by a process of attrition as scientific knowledge progresses. Thus a natural question to ask is whether or not the tendency will stop before all *eidetic* (that is, form-like) truth has become contingent. To Husserl, for example, Euclidean geometry appeared "immediately evident and therefore indubitably correct". Here indeed is an example of the rapid strides made by modern science since his day towards contingency. The caution towards ontological problems which phenomenology is forced to observe wrung from Husserl his famous 'epoché' or abstinence, sometimes called bracketing. It implies, even if it does not absolutely require, the waiving of all existential judgments.

With this in mind, we are led to distinguish sense data from 'constructs', and to consider the rules of correspondence relating them. The inadequacy of ordinary language is the cause of much difficulty in making the necessary distinction between percept and correlate. Hallucinations cannot be dismissed too easily, for they are part of the 'given' in nature, but their spurious character is apparent by reference to constructs. Broadly, science is conceived as self-corrective, a property in which phenomenology is lacking. So long as the latter subject is without a discriminant between the infinite variety of forms which inner experience can take, it is likely to remain somewhat unproductive. It seems doubtful whether this disadvantage can be overcome without doing violence, to some part at least, of Husserl's thought.

Swiss Contributions to Western Civilization

UNDER the title "The Swiss Contribution to Western Civilization", Dr. Raphael E. C. Armattee has set forth an account of the cultural achievements of Switzerland which, as Dr. Julian Huxley suggests in his foreword, most people may well find surprising (Dundalk W. Tempest Dundalgan Press. Pp. 91 5s). As the record shows, Switzerland has sent out many from its free institutions to play their part elsewhere, while its universities have attracted many notable men from abroad. It has provided asylum for a number of distinguished workers anxious to avoid tyranny or persecution in their own countries and Switzerland was almost the only centre of science, learning and culture in Europe which was able to remain out of the War. Its part in the reconstruction of European civilization may well be out of all proportion to its size. Dr. Armattee seeks to distinguish from the outset a few sources of the Swiss contribution, but he makes no claim to be comprehensive

especially in dealing with music and the physical sciences. Chemists will note, for example, that while DDT is mentioned, there is no reference to Engi's work, and the reference to the work of P. Karrer and L. Ruzicka is very brief. Besides the sections dealing with the Swiss contribution to biological sciences, the mathematical and physical sciences, agriculture, research in climatology and meteorology, and such special fields as climatic treatment of lung complaints, and Jungfrau-Joch Alpine research, with its humanitarian contributions, there are notes on the Swiss educational system, vocational and industrial education, industry and commerce, Swiss cultural life and so forth.

Public Health and the Museum

IN 1942, authorities of the South Australian Museum, at the request of the Council for Scientific and Industrial Research, examined the River Murray billabongs and seepage areas for Mollusca which might act as secondary hosts for the trematode worm parasites known to be present in the internees of the Loveday Internment Camps. Crustacea and edible fish—together with Cephalopoda taken from the stomachs of the latter—were also examined. The result of this work was a report strongly recommending that the internees should not be allowed in the vicinity of the river, since there was danger of their excreta infecting local fauna, with the possible consequence that the parasites would be introduced into the Australian population (see Report of the South Australian Museum, Adelaide, for 1942). The report for 1944 shows further work of high social value and importance. During last year the research activities of the Museum were turned towards the microscopic study of insects, the Acarina, (particularly the Trombiculinae), which are associated with the occurrence of scrub typhus in Australia and New Guinea. This work was carried out in collaboration with the Medical Section of the Australian Army, the Scrub Typhus Commission of the U.S.A., as well as with officers of the U.S. Navy. It has resulted in making the South Australian Museum the recognized centre for the identification of these mites; and the Museum's collection of these is now probably the largest in existence.

Consider the Calendar

BHOLA D. PANTH has produced a book with the above title, published by the Bureau of Publications, Teachers College, Columbia University, 1944 (pp. 138), which supplies an excellent account of the calendar, and also shows the great difficulties that beset the path of those who desire calendar reform. Details concerning the basic concepts of ancient calendars among the Babylonians, Egyptians, Hebrews, Mohammedans and others will prove helpful to many, more especially as such information is no longer supplied in every issue of the *Nautical Almanac*. Chapter 4 is devoted to a consideration of various proposals for calendar improvement. Reference to some of these proposals has been made in *Nature* (153, 229, 1944), and it is unnecessary to deal further with the different suggestions made to simplify our calendar. The Special Committee of Enquiry into the Reform of the Calendar of the League of Nations in 1926, in Geneva, received 185 plans from 33 different countries, and although this was evidence of keen interest in the subject, it also showed that a certain amount of opposition is inevitable whatever plan be adopted. It does

not seem highly probable that the nations of the world are yet prepared to accept any particular scheme, though some reform on the lines indicated in this book would certainly simplify matters in many ways. At the end of the book there is a short table which enables the reader to determine the day of the week by the Julian Calendar, A.D. 1-2099, or by the Gregorian Calendar, A.D. 1582-2099.

Lung Cavities in Pulmonary Tuberculosis

DR ALFONSO R. SIMS contributes a paper on the spontaneous healing of cavities in tuberculosis of the lungs to *Aparato Respiratorio y Tuberculosis*, No. 3, 1944, published in Santiago De Chile, in which he gives the results of investigations carried out during the period 1937-42 at the Laenec Sanatorium, when 1,130 cases were dealt with. Males only were admitted—adolescents and adults—and it was found that spontaneous cures amounted to only 8.71 per cent. The importance of the size of the cavity was recognized and cures were not effected in cases where the diameter of the cavity exceeded 4-5 cm. It is remarkable that cavities in the left lung showed a greater tendency to heal spontaneously than those in the right lung. Schminke's classification of the cavities as primary, secondary and tertiary, the first having three and the second two subdivisions, was adopted, and it was found that by far the greatest number of spontaneous cures took place with the first class. Infra-clavicle cavities provided the greatest percentage of spontaneous cures, and those at the apex seldom provided any. It is pointed out that great care is necessary before taking any risks in the treatment of pulmonary tuberculosis, and in all cases the patients should be dealt with while they are confined to bed, or at least under the best possible conditions of repose.

Influenza Epidemics in the United States

ACCORDING to Selwyn D. Collins, head statistician of the United States Public Health Service (*Public Health Rep.*, 59, 1483, 1944), in the eighteen major or minor epidemics of influenza that have occurred in the United States since the beginning of 1918, there has been great variability in the age curve. In the recent outbreak, the curve was in general similar to that of 1928-29 except for a very high incidence among children less than ten years of age. Pneumonic incidence in the current epidemic was far below that of 1918-19. Among persons less than twenty-five years of age the pneumonic rate was less in the current epidemic than in any of the others, but above twenty-five the rates corresponded closely to those recorded for the epidemic of 1928-29. The percentage of the total cases which were complicated by pneumonia in the 1943-44 epidemic was far below the figure for any other epidemic for which figures were available. In most of the epidemics the rates for influenza were consistently higher for females than for males, particularly adult females, with the exception of the 1918-19 epidemic and the minor outbreak of 1940-41, in which there were no obvious sex differences.

Cooper Centenary Fellowships for Veterinary Parasitology

THE Veterinary Educational Trust announces that Cooper Centenary Fellowships have been awarded to Mr J. F. A. Sprent and Mr J. Hobart. The Fellowships were established with the Trust by Messrs Cooper McDougall and Robertson to assist in the

development of veterinary parasitology, and also as a mark of the centenary of that Company. They are normally tenable for one, two or three years, depending upon satisfactory progress in the research undertaken. Mr Sprent qualified as a veterinary surgeon at the Royal Veterinary College in 1939 and took a B.Sc. degree in zoology with first-class honours at Birkbeck College in 1942. Since then he has been a veterinary research officer in the Colonial Veterinary Service, stationed at Vom, Nigeria, where he has carried out important investigations upon helminth infestation of cattle in that country. He hopes to continue to work upon helminth infestations of domestic animals with particular reference to host resistance and the development of a host immunity. Mr Hobart took a B.Sc. degree in zoology with first-class honours in 1943 at University College, London. He has been a demonstrator in zoology at the University College of North Wales, Bangor, and has carried out research upon the ecology of adult sheep blowflies in North Wales. His field work has comprised the trapping of flies in the field and the study of the Dipterous succession in small carcasses. This work was commenced in collaboration with the Entomological Unit of the Agricultural Research Council. Mr Hobart proposes to continue his field work in North Wales and to work upon the physiology of insects at the London School of Hygiene and Tropical Medicine.

Comets

A TELEGRAM from Dr Harlow Shapley announces the rediscovery of Comet Pons Winnecke on May 3, its magnitude being 14. A definitive orbit for this comet was computed by Mr J. G. Porter and members of the Computing Section of the British Astronomical Association; and an ephemeris is given in the "Handbook" for 1945. The correction to the computed perihelion is +2.6 days, and the result must be considered very satisfactory as the comet passes just over 0.6 unit from Jupiter, suffering considerable perturbations. Dr Shapley has also announced the rediscovery of Comet Kopff on May 7d 9h 10m UT, its magnitude being 13. An orbit and ephemeris were computed by Messrs W. E. Beart and W. P. Henderson and are given in the "Handbook" of the British Astronomical Association for 1945. A correction of about -8 m in R.A. to the ephemeris is indicated from the observation.

Announcements

THE Catherine Wolfe Bruce Medal (commonly called the Bruce Medal) for 1945 of the Astronomical Society of the Pacific has been awarded to Prof E. A. Milne Rouse Ball professor of mathematics in the University of Oxford, for "distinguished services to astronomy". The medal is awarded on the recommendation of the directors of six observatories, of which two are in Europe. Previous British holders of this Medal have been Gill, Huggins, Dyson, Eddington, Turner, A. Fowler and J. S. Plaskett.

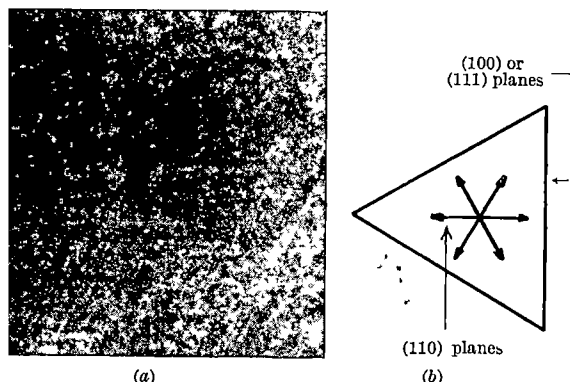
PROF N. R. DHAR, formerly professor of chemistry in the University of Allahabad, has given the University of Calcutta an endowment of approximately one lakh of rupees (about £7,500) for "perpetuating the memory of Acharya Sir Prafulla Chandra Ray and in furtherance of establishing a University College of Agriculture". Prof Dhar states that he hopes to make a further donation of similar amount at a later date.

LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications.

Striated Structure of Age-hardened Alloys

It is well known that age-hardening of alloys is related to a transformation of the crystal lattice, which takes place inside the crystal; this transformation precedes and prepares the formation of a precipitate from the over-saturated solid solution. The microscopical examination of the crystal surface in the earlier stages of age-hardening shows the existence of one or several systems of parallel striations (see refs 1, 2 for aluminium-copper alloys (per cent Cu), refs 3, 4 for copper-beryllium alloys (2 per cent Be), ref 5 for aluminium-zinc alloys, etc). These striations appear on the sample surface after polishing and convenient etching (see striation), but they may also appear in another way. If the quenched sample is first polished, then age-hardened, the metal surface becomes spontaneously striated. In the case of copper-beryllium alloys, for example, the depth of the striations is very noticeable



(a) Copper-beryllium, aged 4 hr at 315°, after electrolytic polishing
(b) Direction of crystallographic planes, determined by X-ray pattern

What is the origin of these striations which follow age-hardening? Opinions are widely divergent. According to some, they are the trace of glide planes on the sample surface, gliding being due to mechanical stresses produced by the lattice transformations accompanying the age-hardening. On the other hand, Wassermann⁶ attributed the striated structure not to glide-planes, but to mechanical twinning resulting in quenching stresses. A third explanation which has been proposed is the following: the striations are due to the presence of a very fine-grained precipitate, the size of the crystallites being below the resolving power of the best microscopes. The formation of lines of determined orientation are due to the teardrop-shaped form of the initial grains of precipitate, which has been demonstrated by X-ray scattering terms. But this explanation is not consistent with the spontaneous appearance of striations on an alloy surface polished before age-hardening and not etched. A way of deciding between these hypotheses seemed to us to be the determination of the orientation of the striation in relation to the crystal axes. Then, if the striations are due to gliding, they must be parallel to (111) planes (in the case of aluminium and copper alloys), but if they are due to some precipita-

tion, it might be expected that they would be parallel to (100) planes, since the crystals of the precipitate are flat and directed along those planes^{1,3}.

We have carried out this experiment with very coarse-grained samples, in the case of copper-beryllium and aluminium-copper alloys. The crystal axes were determined by back-reflexion Laue patterns. We found that all observed striation systems are parallel to the intersection of some (110) planes with the examined surface. But each (110) plane does not give rise to a striation system. Thus the striated structure of age-hardened alloys is neither related to ordinary glide-planes nor to precipitation planes.

The following explanation accounts for our observations. In the two alloys examined, the solid solution transformation begins by the gathering of the solvated atoms in small areas of some (100) planes. Further, the local enrichment in foreign atoms of these planes produces variations of the interplanar (100) spacings. In the case of copper-beryllium alloy, for example, the parameter of the cell decreases from 3.6 Å (solid solution lattice) to 2.7 Å (precipitate lattice). Then the domain where the beryllium atoms are gathered undergoes a great diminution of volume, which produces the observed depressions upon the metal surface. We may assume that the dislocations between beryllium-rich domains and undisturbed crystal regions take place along (110) planes for these planes are normal to base planes of the precipitate and are very important both in the solid solution and precipitate crystals. The result is that the striations, which are the limits between depressions of different value, are parallel to (110) planes.

In the case of aluminium-copper alloys, the difference between the volume of solid solution and precipitate is much less than for copper-beryllium alloys, and it is observed, in fact, that the striations are much less pronounced.

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¹ Calvet, J., Jacquet, P., and Guinier, A., *J Inst Metals*, **65**, 121 (1939).

² Gayler, M. L. V., and Parkhouse, R., *J Inst Metals*, **66**, 67 (1940).

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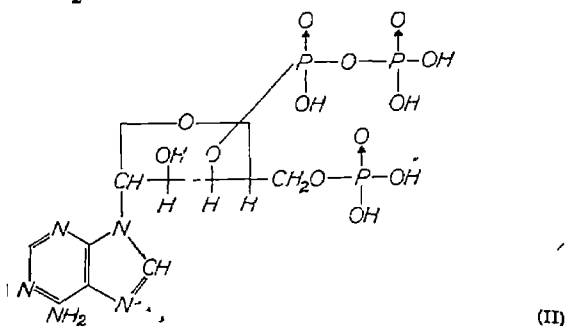
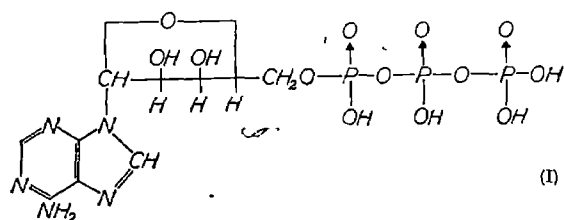
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⁶ Wassermann, G., *Z Metallkunde*, **33**, 62 (1938).

Structure of Adenosine Di- and Tri-Phosphate

DEFINITE proof of the constitution of adenosine diphosphate and adenosine triphosphate, desirable because of its significance both for the structure of the co-dehydrogenases and of the intrinsic interest of the adenosine polyphosphates, has not hitherto been presented. The usual formulation of adenosine triphosphate as adenosine 5'-triphosphate (I) (Lohmann¹) is in doubt only as regards the mode of attachment of the labile phosphoryl groups to the 5'-phosphoribofuranoside residue, the formation of muscle adenylic acid (adenosine 5'-phosphate) on hydrolysis of adenosine triphosphate and of inosine triphosphate by deamination virtually excludes the location of these phosphoryl groups elsewhere in the molecule.



Structure (I) finds strong support in the careful work of Lohmann¹ on the alkaline titration of adenosine di- and tri-phosphate, he found that the latter contains three primary and one secondary, and the former two primary and one secondary acidic groupings. Other workers (Sato², Barrenscheen and Jachimowicz³) have, however, claimed that it is possible using certain enzyme preparations to remove the acid-stable (5') phosphate residue from adenosine triphosphate, leaving the acid-labile residues intact. This claim is incompatible with the Lohmann formula and, if substantiated, would indicate that the acid-labile phosphate groupings are attached to a second hydroxyl of the ribofuranoside as, for example, in (II).

A decision between (I) and alternatives of type (II) is clearly possible given a test capable of detecting unambiguously the presence of an α -glycol grouping, the Klimek-Parnas test⁴ (formation of a deep blue copper complex) and the Boeseken boric acid reaction were both found positive for adenosine triphosphate⁴, but while this supports structure (I), the tests are not considered decisive in view of the complexity of the molecule. We have recently shown⁵ that the structure of certain nucleosides and nucleotides can be determined by titration with sodium metaperiodate in the manner described for the simpler O-glycosides by Jackson and Hudson⁶, thus adenosine and muscle adenylic acid each containing one α -glycol grouping were found to consume 1 mol metaperiodate, while yeast adenylic acid (adenosine 3'-phosphate), in which one of the α -glycolic hydroxyls is esterified with phosphoric acid, was unaffected by this reagent. We have now extended the method to the study of adenosine triphosphate and find that this substance consumes, almost exactly 1 mol metaperiodate. Details of the experimental procedure follow.

Barium⁷ adenosine triphosphate prepared from rabbit muscle by the method of Barrenscheen and Filz⁷, and purified according to Kerr⁸ until the P/N ratio was constant, was washed with absolute alcohol and dried *in vacuo* at room temperature over calcium chloride. The purity of this material was shown by determination of the atomic ratio acid-labile P/total P/N = 1.99/3.00/5.00, the theoretical value is 2/3/5. Inorganic phosphate present was less than 1 per cent of the total phosphate. Phosphorus determinations

were carried out colorimetrically by the method Allen⁹, nitrogen by micro-Kjeldahl.

451.6 mgm of this material was dissolved in a mixture of 2 c.c. water and 2 c.c. *N* hydrochloric acid, 5 c.c. water containing 0.65 gm $\text{Na}_2\text{SO}_4 \cdot 10\text{H}_2\text{O}$ added, and after 5 minutes the solution was neutralized (*pH* 6.8–7.2) with 2 c.c. *N* caustic soda. Barium sulphate was centrifuged off, washed with water, and the supernatant liquid and washings combined and made up to 50 c.c. with water. Aliquots of the solution were assayed (in duplicate) for phosphorus and nitrogen with the following results: Inorganic P, < 1 per cent of total, acid-labile P, 0.4 mgm/c.c., total P, 0.938 mgm/c.c., acid-labile P/acid-stable P, 1.99/1, N, 0.744 mgm/c.c. The solution was thus 0.104 (± 3 per cent) *M* in adenosine triphosphate. To the major portion of the solution (40 c.c.) 5 c.c. of 0.2536 *M* sodium metaperiodate in 5 c.c. water were added, and the mixture set as at 19°, aliquots being removed at suitable intervals for estimation of unchanged periodate by titration with *N*/10 sodium arsenite. After 48 hours no further uptake of oxidant took place, 0.440 millimol had been consumed, corresponding to 1.06 mol per mol adenosine triphosphate.

We regard the consumption of 1 molar proportion of sodium metaperiodate by adenosine triphosphate under these conditions as conclusive proof of presence in the latter of an unsubstituted α -glycol grouping, that is, structure (I) ascribed to adenosine triphosphate by Lohmann, and the corresponding 5'-pyrophosphate formula for adenosine diphosphate correctly represent these substances. Since, according to Vestin *et al.*¹⁰ an adenosine diphosphate residue forms part of the coenzyme molecule, the results of our present work support the usually accepted formula of this substance. Experiments to test metaperiodate consumption of coenzyme and the related triphosphopyridine nucleotide are at present in progress.

We are indebted to Dr L. P. Kendal, of the University of Manchester, for advice and assistance in connexion with the preparation of barium adenosine triphosphate.

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A. R. TODD

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¹ Lohmann, *Biochem. Z.*, **254**, 381 (1932), **282**, 120 (1935).

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Lecithin and Venom Haemolysis

It is well known that different species erythrocytes exhibit wide variations in their susceptibility to venom haemolysis. Some, such as those of the sheep, the goat and the ox, are totally resistant, while others, like those of the guinea and the dog, are very susceptible. Venoms also vary greatly in their haemolytic activity. Those obtained from the Colubridae class are haemolytic in varying degrees, while the Viperidae species of snakes and venoms which are mostly non-haemolytic. In

resence of a trace of lecithin, however, all species of erythrocytes susceptible or refractory lyse very readily with all venoms irrespective of their nature.

Since the discovery of this remarkable venom-activating property of lecithin, the mechanism of the direct haemolytic action of a native venom upon a susceptible species of red blood corpuscle has been supposed to be the same as that of its indirect haemolytic action in the presence of extracellular lecithin, the lecithin in the former case being assumed to be supplied by the corpuscles concerned (Kyes and Sachs¹). The difference in the susceptibility of various species of erythrocytes, however, was supposed to depend not on their respective total lecithin contents but on the extent to which this intracellular lecithin was free or available for venom activation.

As to the nature and mode of formation of this haemolysin, Kyes² believed it to be a synthetic product resulting from a combination of a venom and a lecithin quota (lecithid), while Coca³ and others regarded it simply as one of the split products of lecithin, namely, desoleolecithin, or lecithin from which one molecule of fatty acid has been removed by the enzymatic action of the venom lipase.

Roy and Chopra⁴, and again Roy⁵, from a comparative study of some of the biochemical properties of venoms obtained from the cobra and the Russell's viper, as representing the Colubridae and the Viperidae, found that the former contained both an esterase (butyric) and a lecithinase, but the latter contained a lecithinase but no esterase. The esterase activity of cobra venom, however, does not run parallel to its haemolytic activity, as it is lost by heating the venom solution to 56°C for half an hour, the haemolytic activity remaining almost unimpaired by this treatment. But if the lecithinase activity of a venom is regarded as the criterion for determining its haemolytic behaviour, as has been assumed even by some recent workers (Huges⁶), then we are unable to explain why the Russell's viper venom, which contains a fairly strong lecithinase capable of forming a very active haemolysin with lecithin, should be non-haemolytic even towards the susceptible species of red blood corpuscle.

The presence of free or 'available' lecithin in the large majority of the species of erythrocytes, therefore, seems to be highly improbable, and the mechanism of the direct haemolytic action of a native venom seems to bear no relation to its lecithinase content, and it is entirely different from that of its indirect activation in the presence of extracellular lecithin. Since the venoms obtained from all species of snakes contain lecithinase A (Contardi and Ercohl)⁷ which splits up lecithin only in a particular manner, namely, into a molecule of oleic acid and desoleolecithin (lysolecithin), and since the latter is capable of dissolving even the most resistant species of red blood corpuscle, their universal lytic action on these corpuscles in the presence of lecithin is self-evident. Another point of difference between the action of native venom and that of the lysolecithin it forms is the presence of lecithin is, that while the former does not lyse an emulsion of cholesterol, the latter dissolves it freely. The formation of lysolecithin is also attended with a remarkable lowering in the surface tension of the solution. It appears probable that with lysolecithin the process of haemolysis is initiated by solution of the corpuscular membrane cholesterol, and when the corpuscular structure is thus somewhat loosened, the sudden change in the surface tension of the solution effects a rapid separation of the

stroma-haemoglobin union. There is reason to believe (to be reported later on) that bile salt haemolysis is brought about in a similar manner.

As the cholesterol solvents are usually those which also materially lower surface tension, it may be stated as a general proposition that substances which dissolve cholesterol will haemolyse all species of red blood corpuscle, though the converse is not true. This, however, leaves the mode of the direct haemolytic action of a native venom still unexplained.

A detailed account of the work will be published elsewhere.

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¹ *Ber Klin Woch*, 40, 21, 57, 82 (1903)

² *Ber Klin Woch*, 40, 956, 982 (1903)

³ *Z Immunität*, 12, 134 (1912)

⁴ *Ind J. Med Res*, 28, 241 (1938)

⁵ *Ind J Med. Res*, 28, 249 (1938)

⁶ *Biochem J*, 29, 437 (1935)

⁷ *Biochem Z*, 81, 275 (1933)

Aliphatic Acids, Fungi and *Mycobacterium tuberculosis*

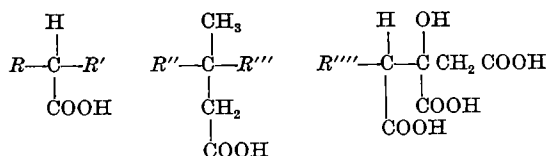
THERE is no doubt that long-chain aliphatic acids are intimately connected with the metabolism of *Mycobacterium tuberculosis*. Anderson¹ has isolated a number of such acids, including a long-chain hydroxy-acid, from the fatty envelope of this organism. Adams² has shown that acids of the type $RR'CH\text{COOH}$ (containing 16-18 carbon atoms) are, to a certain extent, bactericidal towards *M. tuberculosis*, and Robinson³ has synthesized acids of the type $R''R'''C(CH_3)CH_2\text{COOH}$ (containing 16-18 carbon atoms) which also showed bactericidal activity against this same organism.

So long ago as 1910, Vaudremér⁴ observed that tubercle bacilli were modified by maceration in extracts made from *Aspergillus fumigatus* and *Penicillium glaucum*. A filtrate from a medium on which *Aspergillus fumigatus* had been grown has been found by Soltys⁵ to have an antibiotic action towards *M. tuberculosis*, a similar observation with regard to an *Aspergillus* strain has recently been made by Kallós⁶. Extracts obtained from the culture media of *Penicillium notatum* have been shown by Smith and Emmart⁷ to exhibit "in vitro" marked activity at certain concentrations, and Miller and Rekate⁸ have observed an inhibition of growth of tubercle bacilli by suspensions of a mould which probably belonged to the genus *Penicillium*. It is thus clear that the metabolic products of certain species of *Penicillium* and *Aspergillus* are antibacterial towards *M. tuberculosis*, and it may be noteworthy (see below) that fungi belonging to these genera are well known for their ability to produce citric acid.

Agaric acid—obtained from a Basidiomycete, *Polyporus officinalis*, Vill.—has been employed for many years in the treatment of night-sweats of phthisis. That a fungus-product should have been used for the alleviation of a condition due to *M. tuberculosis* is a curious coincidence, and more especially so, since agaric acid is known to be a long-chain homologue of citric acid (*n*-hexadecyl-citric acid^{9,10}). Agaric acid is, however, said to act pharmacologically as an anhydrotic.

The production of bacteriostatic substances by the larger Basidiomycetes has been investigated¹¹ by Wilkins and Harris, who state that their "results indicate that the larger Basidiomycetes are among the more promising fungus groups which produce antibiotics." These authors, however, base their opinion on the results of tests made mainly on *B. coli* and *Staph. aureus*.

There is a certain structural relationship between agaric acid and those synthetic acids which have been shown to be active against *M. tuberculosis*



Total number of C atoms in molecule

(Adams)	(Robinson)	Agaric acid
16-18	16-18	22

The coincidences are too many to be overlooked, and in my opinion warrant (a) a determination of the antibacterial activity of agaric acid towards *M. tuberculosis*, and (b) an investigation of the synthesis and chemotherapy of related compounds. Both aspects of this investigation are in progress.

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¹ Anderson, *Chem. Rev.*, **29**, 225 (1941)

² Adams *et al.*, *J. Amer. Chem. Soc.*, **51**, 1261 (1929)

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⁹ Thoms and Vogelsang, *Ann. Chem.*, **357**, 145 (1907)

¹⁰ Passerini and Banti, *Chem. Z.*, **1**, 1432 (1931)

¹¹ Wilkins and Harris, *Ann. Appl. Biol.*, **31**, 261 (1944)

Acid Salts of Organic Acids as pH-Standards

MANY monobasic organic acids form crystalline acid sodium or potassium salts (for example, potassium hydrogen benzoate, $\text{KC}_7\text{H}_5\text{O}_2 \cdot \text{H}_2\text{C}_7\text{H}_5\text{O}_2$). A solution of such a compound is equivalent to one of the acid half neutralized with a strong base, and it constitutes a buffer solution that is very readily prepared and that has a pH-value approximately equal to, but slightly lower than, $pK (= -\log K)$ for the acid. Their general usefulness is limited by the low solubilities of most organic acids, and by the comparatively restricted range of dissociation constants among acids otherwise suitable.

Preliminary measurements at 26° show that $M/50$ potassium hydrogen benzoate has $pH = 4.15$ and $M/30$ potassium hydrogen phenylacetate $pH = 4.23$, the pH values being on the scale recommended by Hitchcock and Taylor¹. These solutions are suggested as possible pH-standards, and they are being further investigated from this point of view, together with other similar systems.

Potassium hydrogen phthalate has long been recognized as a pH-standard, but this compound is not strictly analogous to those now suggested. Phthalic acid is dibasic, the buffering capacity of

phthalic acid-caustic potash mixtures is actually at a minimum for the composition corresponding to $\text{KHC}_8\text{H}_4\text{O}_4$, and there is appreciable buffering only because pK_1 and pK_2 differ by not more than $2\frac{1}{2}$ units. On the other hand, borax, which in solution is stoichiometrically equivalent to $\text{NaBO}_2 \cdot \text{HBO}_2$, gives a true buffer solution, and is an acid salt of the type discussed above.

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March 26

¹ *J. Amer. Chem. Soc.*, **59**, 1812 (1937), **60**, 2710 (1938)

Molar Polarization and Radius-Ratio of Ions

THE interionic distance in the crystalline state is not exactly additive for the radii of the constituent ions. Fajans¹ explains it in terms of polarization. Pauling², on the other hand, neglecting the effect of polarization, explains these deviations from additivity as the effect of the radius-ratio, ρ , of the constituent cation to anion. In this communication a set of empirical equations concerning molar volumes and molar refractions of alkali halides will be first presented. Making use of these empirical equations, we are able to assign definite values to polarization and obtain a function of ρ which, though different in form from Pauling's function, $F(\rho)$, gives identical values.

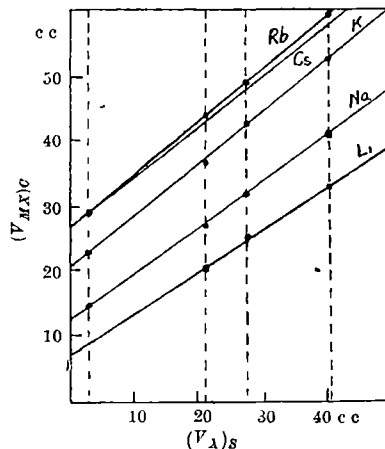


Fig 1

In plotting the molar volume³, $(V_{MX})_C$, for halide of each alkali in the crystalline state against the volume of halide ions in solution of infinite dilution $(V_X)_S$ ^{4,5}, as shown in Fig 1, a set of straight lines obtained which can be expressed by the general equation

$$(V_{MX})_C = a_1 + b_1 (V_X)_S,$$

where a_1 and b_1 are characteristic constants for each cation.

I have previously shown⁶ that the volume, $(V)_S$, of ions in infinitely dilute solution is a linear function of the volume, V , calculated from Pauling's radii. Therefore $(V_{MX})_C$ bears a linear relation with the volume of anions, V_X .

$$(V_{MX})_C = a_2 + b_2 V_X$$

Taking the volume of ions in solution of infinite dilution as reference, one may consider a_1 in equation (1) as the volume of cations in crystals under the loosening influence of anions and $b_1(VX)_S$ as the polarized volume of anions

The molar refraction² of alkali halides, $(RMX)_C$, in crystals can be also expressed as a linear function of the refraction of gaseous anions $(RX)_G$

$$(RMX)_C = a_0 + b_0 (RX)_G \quad (3)$$

The graph is similar in shape to Fig 1

Ionic polarization If we subtract from each side equation (1) the molar volume of MX in solution, $(MX)_S$, we get

$$(MX)_S = (VMX)_C - (VMX)_S = [a_1 - (VM)_S] - (1 - b_1)(VX)_S = L - P(VX)_S \quad (4)$$

Similarly for molar refraction,

$$(MX)_S = (RMX)_C - (RMX)_G = [a_0 - (RM)_G] - (1 - b_0)(RX)_G = L' - P'(RX)_G \quad (5)$$

This relation is shown in Fig 2. Equation (4), if extended, will give a similar set of lines

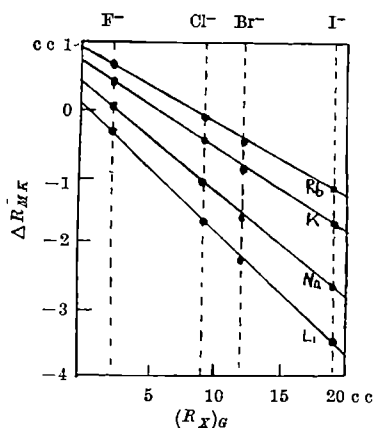


Fig 2

The terms L and L' can be called, following the concepts of Fajans¹, the loosening constants of cations, while P and P' are the polarizing strengths of anions. Fig 2 shows that the polarizing strength increases in the order lithium, sodium, potassium and rubidium. Ionic polarization is the combined result of these two factors, L and P

Function of radius-ratio of ions Starting from equation (2) and making use of the classical equation expressing the interionic distance D in crystals in terms of molar volume V , $D = 0.936V^{1/3}$, one gets

$$D = 0.936(a_2 + 4/3 N\pi b_2 r_X^3)^{1/3},$$

where r represents Pauling's ionic radius. Then Pauling's function of radius-ratio can be expressed in the form

$$F(\rho) = \frac{D}{r_M + r_X} = \frac{0.936(m\rho^3 + n)^{1/3}}{\rho + 1}, \quad (6)$$

where

$$\rho \equiv \frac{r_M}{r_X}, m \equiv \frac{a_2}{r_M^3}, n \equiv \frac{4}{3} N\pi b_2$$

Fig 3, the smooth curve is Pauling's function, $F(\rho)$, and dots represent the values calculated from the new function as shown on the right-hand side of equation (6)

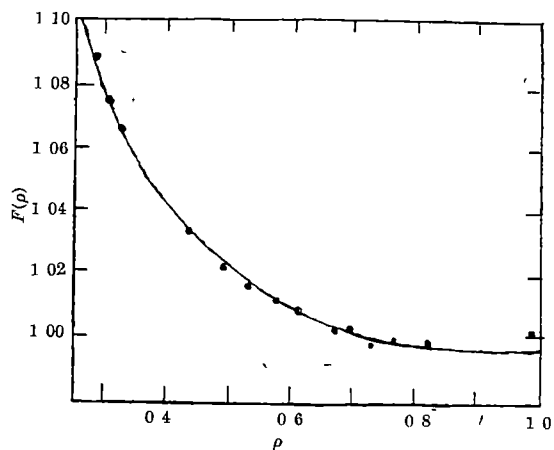


Fig 3

In conclusion, the interionic distance D in crystals is shown to be calculable from an equation, equation (6), derived from the equation of polarization and at the same time related to a function of the radius-ratio. A more detailed presentation will appear in the *Journal of the Chinese Chemical Society* (11, No 2)

Reprints of this letter can be obtained from the British Council Cultural Scientific Office in China, via the British Council, Science Department, 3 Hanover Street, London, W 1

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⁷ Fajans, K, and Joos, *Z Phys*, 23, 1 (1924)

Red Shift in the Anagalactic Nebulae

Mr A J Shneiderov, in his letter¹ putting forward an explanation of the 'red shift', appears to have overlooked, in examining the effect of gravitational attraction on the frequency of a photon, the fact that the nebula from which the photon originated would exert a contrary effect on the photon to that exerted by the galaxy. If the nebula were of equal mass to the galaxy, then the two effects would balance and no frequency change result.

To explain the red shift in this way would therefore require the galaxy to be much more massive than the great majority of the spiral nebulae so far examined spectroscopically. I believe this is not in accordance with the latest views on the comparative masses of the galaxy and the spiral nebulae.

Furthermore, Mr Shneiderov's formula for the observed energy of a photon originating 'out of the blue' attributes a lower energy to the photon after it has realized on its initial gravitational potential energy than it had at first. The opposite would appear more reasonable. Were this so, no change in frequency would again be expected in the case of equality of mass of radiator and receiver. If, however, the galaxy were smaller than the great majority of the spiral nebulae, a red shift would be expected.

It may be conceivable that most of the extra-galactic nebulae so far examined spectroscopically are unusually large specimens (except perhaps the nearer ones, some of which show a small 'blue shift') so that this modification of Mr Shneiderov's idea might be slightly more plausible

E L DEACON

Meteorological Section,
C D E S,
Porton, Wilts

¹ *Nature*, 155, 332 (1945).

THERE is a somewhat obvious objection to Mr A J Shneiderov's suggestion¹ regarding the red shift in the light received from distant nebulae

If the frequency of light entering our galaxy is altered by its gravitational field, then it must be presumed that the frequency must also have been altered by the gravitational field of the galaxy in which the light originated, but in an opposite sense, so that the two effects would tend to neutralize each other. Also the shift would vary according to the part of the distant galaxy in which the light originated, which does not appear to be the case.

The choice of explanations of the red shift would appear to lie among the following: (i) An increase in distance with lapse of time (Doppler effect) (ii) An increase in the frequency of the atomic oscillators with lapse of time (iii) A decrease in the velocity of light with lapse of time (iv) A change in the frequency (wave-length) of the light in its passage through space

Our choice is limited by our definitions of length and time, which serve to eliminate two of the four possible explanations, or which impose two conditions which the explanation must satisfy

The first three explanations cover familiar ground, but the fourth is also perhaps deserving of consideration. Recent theory has tended to lay special emphasis on quantum effects, but there would seem to be the possibility that the absorption of light in intergalactic space containing molecules, atoms and electrons might be connected with a slight change of frequency

K E EDGEWORTH

Cherbury, Booterstown,
Co Dublin March 23

¹ *Nature*, 155, 332 (1945)

Breeding of the Harvest Mouse in Captivity

THE harvest mouse, *Microtus minutus*, is easy to keep in captivity, this tiny beast flourishing in a roomy cage as many naturalists have proved. One of mine lived with me for nearly four years and died apparently of senile decay. But it has rarely been bred in confinement, indeed I believe that until quite recently the late Miss Phyllis Kelway's achievement of breeding a litter of harvest mice was unique. I say until 'quite recently' because two females in my possession have just produced a litter each. The first family two thirds grown was out and running about on May 12 and the second litter came out, being but half-grown, on May 15. An accurate count was difficult for the small animals kept running in and out of the straw, hay, etc., in their quarters, but my provisional estimate was three in litter number one

and four in litter number two. This may have to be modified.

This establishment consists of one old male and two old females. These, and eight other harvest mice domiciled in another cage, came to me last year through the kindness of Mr W B Atlee from Roms in Hants. Those in the more crowded cage have not shown any signs of breeding. I attribute the success of those in cage number one to roomy quarters as except for being fed and watered—they are most thirsty little animals—to being left undisturbed. They are fed on grain, occasional apple, bread dipped in milk and nuts. They also eat a considerable amount of green food, that is, grass, etc.

FRANCES PITT

The Albynes, Bridgnorth
May 16

Regional International Universities

THE leading article¹ on Dr Joseph Needham's article on "An International Science Co-operation Service" is opportune. We regret that Prof G W Keeton's book, "The Case for an International University" is at present not available to us, but it is obvious that some such organization must be permanently established. We feel, however, that such a service should embrace activities much wider than the mere distribution and exchange of scientific information.

There should be a committee of the United Nations to deal with educational and scientific matters. One of its terms of reference should be the creation of regional international universities where teachers, research workers, postgraduates (and even undergraduate students) of varying nationalities would work under a common roof. It should select the person and, what is most important, indicate the type of subjects to be studied. Subjects that have a universal application and interest should have prior consideration, for example, science, history, law, economic preventive medicine, likewise, any new problem that appears to have international implications should be included.

Such international universities could supplement existing national universities, but should in no way interfere with their autonomy.

W C W NIXON
W LAQUEUR

Istanbul University

¹ *Nature*, 154, 497 (1944)

Kinematical Relativity and the Nebular Red-Shift

PROF MILNE¹ has not met my objection. I have read his mathematics, and it does not explain a real, objective effect (the red-shift) can be "due to recession" which, according to kinematical relativity is a subjective cause which can be transformed away by an act of thought. Prof Milne's claim that an absurdity must be accepted unless one locates a flaw in the argument leading to it seems to me to call for further comment.

HERBERT DINGLE

Imperial College,
London, S W 7

¹ *Nature*, 155, 511 (1945)

[We regret there is no space to continue this discussion.—EDITORS]

PHOTOMETRIC RECORD OF THE MODE OF ACTION OF SULPHONAMIDES AND PENICILLIN

by DR. P. BONÉT-MAURY and R. PÉRAULT
Institut Alfred Fournier (Service de Chimiothérapie) and
Institut du Radium, Paris

WE have obtained these records with the 'différentiel bio-photomètre' recently built by Bonét-Maury and Walen¹ in the Radium Institute, Paris, that apparatus automatically records the variations of opacity of six bacterial suspensions. The growth of the micro-organisms is carried out at 37° C, in special 2-ml flasks, mechanically shaken during the whole experiment while exposed to the beam of light.

The growth of *Staphylococcus aureus*, in glucose peptone broth, gives, for increasing inoculates, parallel curves (Fig 1). The standardization of the photometer with bacterial suspension of known

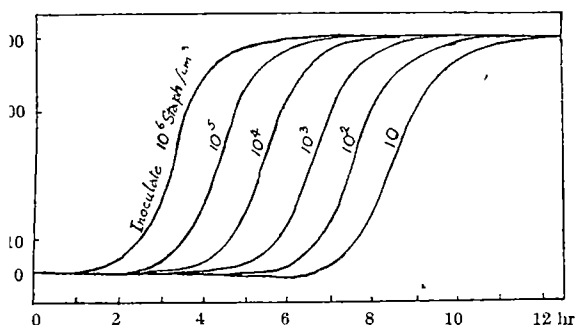


Fig 1 NORMAL GROWTH OF STAPHYLOCOCCUS, WITH DIFFERENT INOCULATES

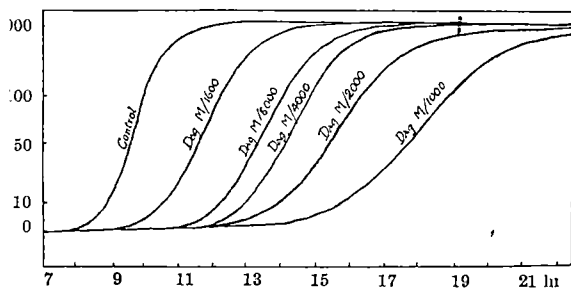


Fig 2 DAGENAN AND STAPHYLOCOCCUS CONTROL INOCULATE, 10^6 STAPH/CM³

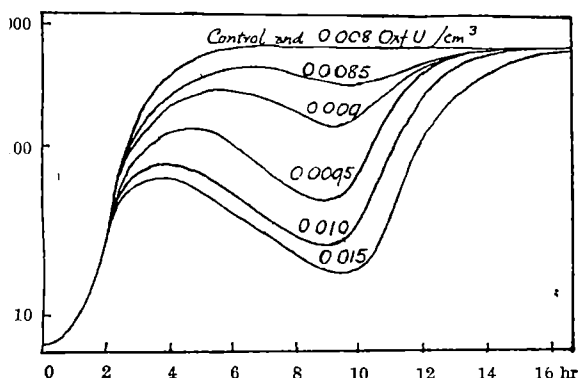


Fig 3 PENICILLIN AND STAPHYLOCOCCUS INOCULATE, 5×10^6 GM/CM³

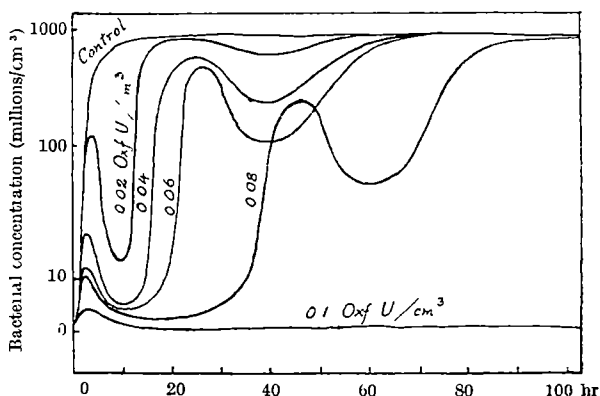


Fig 4 PENICILLIN AND STAPHYLOCOCCUS INOCULATE 5×10^6 GM/CM³

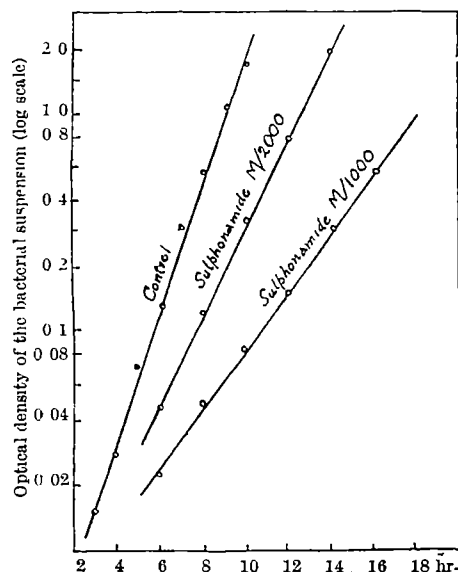


Fig 5 SULPHONAMIDE (1162 F) AND *B. coli* LOGARITHMIC LAW IN SYNTHETIC MEDIUM

potency enables one to plot these curves on semi-logarithmic paper, parallel straight lines are then obtained showing that the growth of *Staphylococcus* follows indeed a regular logarithmic growth.

With sulphonamides (Dagenan, 1162 F) in the same broth, it is found by the same graphic means that the curves obtained always indicate logarithmic growth, but the higher the concentration of sulphonamide the slower is the rate of growth (Fig 2). With *B. coli* in synthetic medium, without any anti-sulphonamide agent, the same curves are observed (Fig 5). Everything is exactly as if, at each bipartition, the culture treated with sulphonamide was retarded by a given quantity when compared with the test culture, so that the distance between the two curves regularly increases with time. Thus we can explain why the action of sulphonamide appears to be stronger when it acts on a poor inoculate than on a high bacterial concentration.

It seems to us, from those results, that the sulphonamides, for the concentrations usually reached in the organism, do not stop but just delay the proliferation of the pathogenic micro-organism. In summing up, sulphonamides act on the bacterial proliferation like a fall of temperature, by a slackening of the reaction of synthesis.

With penicillin we observe quite different curves. With high concentrations (100 Oxf u/cm³) proliferation stops almost immediately, followed by a slow lysis of the bacteria², these phenomena seem to be practically independent of the initial concentration of germs. The low concentrations of penicillin (0.1–0.008 Oxf u/cm³) produce particularly interesting curves (Figs 3 and 4).

We observe that, even for very low concentrations, penicillin not only stops the bacterial proliferation in a very short time, but also later shows a very powerful lytic action, the lysis even appears to be more pronounced for higher concentrations.

But if we prolong the recording, a new start of the proliferation is regularly observed (post-lytic growth) followed by a second partial lysis, which is finally followed by a second post-lytic growth. The latter does not appear to be normal, because the final bacterial concentration remains always lower than the test concentration. The results were the same for six different penicillins tested (English, American and French) and correspond to more than fifty curves recorded.

These curves explain the difficulties met with in the titration of penicillin by the dilution method, and the abnormal opacities so often observed when the dilutions are tested photometrically, they probably correspond to the post-lytic proliferation phenomenon. The curves recorded seem to be sufficiently regular, so that we may hope to have a new method of titration by which a given quantity of standard penicillin should be connected with each curve.

¹ Bonét-Maury and Walen, *Ann. Inst. Pasteur*, in the press.
² Nitti, Fossaert and Faguet, *Ann. Inst. Pasteur*, 70, 80 (1944).

PROF. BORIS KELLER

By PROF. N. V. TURBIN

THE Soviet Government has awarded the Order of the Red Banner of Labour to Prof. Boris Keller as a mark of appreciation of his many years of scientific and pedagogical work. Keller was one of the first Russian botanists to make an ecologo-physiological study of the vegetation of the Russian steppes, deserts and semi-arid regions. He aimed at obtaining concrete information on the ways and means by which the evolution of plants takes place in Nature and which lead to their adaptation to differing ecological conditions. He also studied these regions with the view of using them for agricultural purposes.

In studying the flora of the semi-arid regions he made use of his own method of 'ecological series' to study plant associations in connexion with their environment, the method is now widely employed for all phytogeographical work. Keller introduced the conception 'semi-arid region' into the science of phytogeography and was guided by the agrarian peculiarities of these regions as well as by natural and historical features. He compiled one of the best classifications of the steppes and was a pioneer in producing a theory of plant communities, one of the most important divisions of the science.

These investigations are recorded in Keller's works "In the Semi-Arid Zone", "Botanico-Geographical Research in the Zaisan district of Semipalatinsk Region", "In the Valleys and Mountains of the Altai", "Flora of the Russian Steppes, Deserts and

Semi-Deserts" (1923) and others which are still used in Russian universities as classic examples of phytogeographical research in Russia.

All of Keller's investigations pursued the same object—the all-round study of the plant and the dynamics of its relations to its environment. His ecologo-physiological researches form the complement of his physiogeographical field work.

His work on the imperviousness of plants to droughts and salification have become well known. He regards halophytes and xerophytes as examples of the ability of plants to adapt themselves to extreme forms of life. Keller revealed the physiological nature of this adaptation in halophytes and xerophytes and produced a picture of the evolution of these ecological forms.

A group of peculiar fleshy halophytes not only thrives in salified soil but also a certain amount of salt in the soil is necessary to enable them to attain full growth and to protect them against unfavourable factors in the environment, this is a confirmation of the theory propounded by Prof. K. A. Timiryazev—to the effect that "plants are capable of converting hostile elements in their environment to their own use".

On the basis of his ecological and geobotanical researches, Keller explained the general laws of the distribution of plants throughout the world and established actual ecological types. To attain this end he has transferred his studies from one branch of botany to another, from classification to anatomy and physiology and back again to classification in order to investigate "the plant as a whole in all its intricate inter-related peculiarities of its structure and the nature of its life".

His direct contact with Nature and ecological physiological experimentation with living plants strengthened his conviction of the changing nature of plants and the connexion of their properties with the natural conditions with which they have come into contact during their evolution.

Keller is a convinced and consistent protagonist of Darwin's theory of evolution, and his own evolutionary views are based on many years of observations made on plants in their natural surroundings and his research in the sphere of ecology.

The Darwinist nature of his approach to the problems of ecology—the plant, its environment and their interrelations—is the most important feature. Keller's ecological and phytogeographical research. This is what we have in mind when we speak of Keller as an important Russian botanist and Darwinist, this is true of his work in the sphere of phytogeography and the ecology of plants, especially his greatest work, "Fundamentals of the Evolution of Plants", which has been written since the War began. In Keller's works the problems of evolution are first raised as ecologo-physiological problems whereby they differ from many other important works on evolution which give the greatest importance to morphological methods.

Keller explains the specific features of the evolution of plants on the basis of the ways in which the plants obtain nourishment and their relations with the environment.

He is of the opinion that the evolution of plants does not depend on casual, isolated mutations but on the selection of those regular changes which first occur in the individual development of the plant as a regular reaction of its adaptive faculties to changes in living conditions and internal relations in the

plant itself, which then bring about a reconstruction of the progeny in the direction indicated. Environment, therefore, is at once a selective and a formative factor, in these circumstances the formation of a species "as a rule embraces simultaneously many, frequently a very large number of individuals, which are then reformed under the influence of a changing environment or when the plant or a whole family, is transferred to a different region"

During recent years Keller has been putting his ideas on the evolution of plants and his conceptions of the fundamental problems of ecology into practice in the Moscow Botanical Gardens of the Academy of Science of the U.S.S.R. which are being built in accordance with his plans

Prof Keller is a member of the Academy of Sciences of the U.S.S.R. and the Lenin Academy of Agriculture, director of the Moscow Botanical Gardens and president of the Turkmen Branch of the Academy of Sciences of the U.S.S.R. He takes an active part in public affairs and is a member of the Central Trade Union Council of the U.S.S.R. and of the Executive Committee of the Moscow Regional Soviet

SOCIAL RELATIONS OF SCIENCE*

THE advent of peace has led to much discussion on the proper place of science in the post-war world. Different currents of opinion range from the extreme view of the need to suppress science on account of the dangers of its application to war, to that which considers that scientific activities need to be greatly increased and co-ordinated in the interests of providing better conditions of life in Great Britain and throughout the world. Not only is there no agreement as to the amount of science needed, but also considerable divergence of opinion on how science should be organized. Some think of science as "a proper occupation for the leisure of an English gentleman", and consider that it is more important that it should be completely free and unorganized than that it should be adequately endowed, while others feel that the full value of science can only be reached if it is organized in relation to practical human activities of production, agriculture and health, and can draw on a far larger share of the national income than it has done hitherto. Those who hold the older views have never realized that the relation of science to society is not fixed but continually changes with the growth of science and the increase of complexity of society. What did well in ancient Greece or Victorian England is not appropriate to the needs of to-day.

Science is not a simple thing, it eludes definition; it is at the same time a professional activity, a body of knowledge, a way of solving problems and an influence on the way in which everyone looks at the world and deals with it. Society is fully entitled to demand that science should be used in solving the problems of providing us with a better standard of living. It would be a very stupid society, however, that attempted to do this without considering the beliefs and ideals of scientific workers and the unity of scientific knowledge, which is such that almost any part of it may turn out to bear on almost any other. The Nazis tried to do this: they discouraged fundamental science and generalized thinking and

thus, in spite of their enormous technical start, failed in war. Men of science who are taking the responsibilities of science seriously are well aware that a proper proportion of effort must be given to fundamental science which has no immediate application. Out of £24 millions, which the Association of Scientific Workers suggests should be budgeted for scientific research in Britain, more than £2 millions would go to fundamental science. The Association is also aware that the actual direction of scientific effort must be in the hands of scientific workers, who alone are competent to know what they are doing.

It is quite possible to plan science, as the example of Britain during the War and the Soviet Union before the War, have shown, in such a way that a continuous link is kept between applied science and fundamental science with a two-way flow of ideas—of new ideas coming from fundamental science to be applied, and of problems coming from the applied field leading to the production of new fundamental theories. The real danger to Great Britain is not that science will be over-organized, but that there will not be nearly enough of organized science. We spend only about one third as much, in proportion, and one tenth in total, as the United States and the Soviet Union on scientific research.

The immediate limiting factor is the number of scientific workers who will be available in the post-war years. With our present educational output, we can never produce scientific workers in adequate numbers, but the importance of this has not been realized, and the additional grants made to the Universities' Grants Committee will scarcely do more than make up for the increased cost of living.

Science is in this situation very largely because its wider influence has never been realized by the public. Science teaching is a belated and unwelcome part of the educational system, and the new Education Bill has not improved matters. Further, the Press generally treats science only as a purveyor of sensational discoveries.

The War, however, has shown millions of people in the Services and the war factories how important science can be. The very demands which are now being made for adequate food, housing and health are known to be based on scientific studies. The new standards can be achieved only by the application of science. Beyond that, we are beginning to see that not only these problems but also many political and social problems depend on science for their solution. With this realization we may hope will come an increasing emphasis on the balanced development of science, on its increasing use in satisfying social needs and on the spread into ordinary life of a scientific way of thinking and acting.

ISLAND FLORA OF THE GULF OF GUINEA

THE three Portuguese islands, S. Tomé, Príncipe and Annobon, which form the subject of this work* lie, together with Fernando Po, in the Gulf of Guinea. All are of comparatively recent volcanic origin and have a typical equatorial climate with considerable rainfall and very high humidity. Geological evidence and the insular character of their

* Catalogue of the Vascular Plants of S. Tomé (with Príncipe and Annobon). By Arthur Wallis Exell, and other members of the Department of Botany. Pp. xi+428. (London: British Museum (Natural History), 1944.) 30s.

* Substance of the Trueman Wood Lecture delivered by Prof. J. D. Searl, F.R.S., before the Royal Society of Arts on May 16.

floras both point to the three islands never having had any land connexions with each other or with the continent. The islands have been visited many times by botanists and their flora is fairly well known, but Mr Exell was able, during a three months visit in 1932-33, to add thirty-one new species, and considers that the mountain forest region in St Thomas and Principe is still by no means exhausted.

The vegetation of St. Thomas, the largest and most diversified of the three islands, is divisible into four regions. The littoral region consists of sand dunes or mangrove swamps. The lower-lying ground up to 800 m, originally occupied by rain forest, is now almost entirely under cultivation. The plantations are mainly devoted to cocoa, coffee, bananas, oil-palms and coco-nut palms. The mountain rain-forest region between 800 m and 1,400 m is remarkable for its richness in Rubiaceae and Euphorbiaceae, and for an equally striking absence of Leguminosae. Epiphytes and lianes are well developed, and the profusion of ferns both as to species and individuals is probably unsurpassed in any other part of Africa. At still higher elevations up to the summit of Mt. Pico (2,024 m), there is developed a mist-forest region, determined by the cool climate, very heavy rainfall and almost constant mist. Here the trees are less lofty and the canopy less dense than in the mountain forest region, and epiphytes and ferns are even more abundant.

In the much smaller island of Principe, what little virgin forest remains seems to resemble that of the lower rain-forest of St Thomas, with Rubiaceae, Euphorbiaceae, Orchidaceae and Filicemae particularly abundant.

The total number of indigenous species on the three islands is 682, of which 171 are endemic, this is a high degree of endemism having regard to the nearness of the continent. Only eleven of these endemic species occur on more than one island and this, together with the fact that each island has a comparatively large number of species found on the mainland but not on the other islands, affords strong evidence that the islands were never connected with each other, but that each received its independent quota from the rich mainland flora.

The information given under each species includes synonymy, distribution within the islands and beyond, and citation of all known specimens in herbaria. Most of the newly described species are figured.

FORTHCOMING EVENTS

Monday, June 11

GAS RESEARCH BOARD (at 1 Grosvenor Place, London, S W 1), at 2 p.m. Annual General Meeting.

ROYAL COLLEGE OF SURGEONS (Lincoln's Inn Fields, London, W C 2), at 4 p.m.—Prof F Davies "The Early Development of the Human Embryo" (Arris and Gale Lecture).

WOMEN'S ENGINEERING SOCIETY, Manchester Branch (at the Engineers' Club, Albert Square, Manchester), at 6.30 p.m.—Miss V Holmes "Women and Workshop Skill".

ROYAL GEOGRAPHICAL SOCIETY (Kensington Gore, London, S W 7), at 8 p.m.—Dr J V Harrison "Journeys in Luristan".

Tuesday, June 12

ROYAL SOCIETY OF ARTS (John Adam Street, Adelphi, London, W C 2), at 1.45 p.m.—Dr F M Walsh, O.B.E. "Infantile Paralysis" (postponed from May 9).

CHEMICAL ENGINEERING GROUP OF THE SOCIETY OF CHEMICAL INDUSTRY and the INSTITUTION OF CHEMICAL ENGINEERS (at the Geological Society, Burlington House, Piccadilly, London, W 1), at 2.30 p.m.—Mr L W Needham and Mr S Lyne "The Use of Suspensions as Heavy Liquids" (postponed from May 8).

QUEKETT MICROSCOPICAL CLUB (at the Royal Society, Burlington House, Piccadilly, London, W 1), at 7.30 p.m.—Mr E Mackie "A Consideration of the Requirements for Cinemicrographic Apparatus".

Wednesday, June 13

INSTITUTE OF PETROLEUM (26 Portland Place, London, W 1), at 5.30 p.m.—Chairman of the Heavy Duty Engine Oils Panel of the Standardization Committee of the Institute "Engine Testing of Heavy Duty Oils".

Thursday, June 14

ROYAL SOCIETY (at Burlington House, Piccadilly, London, W 1) at 4.30 p.m.—Dr G M B Dobson, F.R.S., in collaboration with Mr A W Brewer and Mr B Cwiling "The Meteorology of the Lower Stratosphere" (Bakerian Lecture).

Tuesday, June 12—Wednesday, June 13

INSTITUTION OF GAS ENGINEERS (1, Grosvenor Place, London S W 1) Annual General Meeting.

Friday, June 15—Saturday, June 16

INSTITUTE OF BRITISH FOUNDRYMEN (at the Waldorf Hotel, Aylesbury, London, W C 2)—Annual meeting. Members of the Iron and Steel Institute are also invited to attend.

APPOINTMENTS VACANT

APPLICATIONS are invited for the following appointments on or before the dates mentioned.

LECTURER IN MATHEMATICS at Battersea Polytechnic, London S W 11—The Clerk to the Governing Body (June 11).

SENIOR EXECUTIVE OFFICER responsible primarily for Research and Public Relations, Institute of the Motor Trade—General Secretary, marking envelope "Executive Officer" (June 16).

A LECTURER IN MECHANICAL ENGINEERING, and a LECTURER IN ELECTRICAL ENGINEERING, at West Ham Municipal College—The Education Officer, Education Offices, 95 The Grove, Stratford, London E 15 (June 16).

LECTURER IN CHEMISTRY at the Royal Technical College, Salford. The Principal (June 18).

LECTURER IN PHYSICAL AND INORGANIC CHEMISTRY, Royal Holloway College, Englefield Green, Surrey—The Principal (June 18).

TWO TECHNICAL OFFICERS for the Ministry of Food, to supervise factory production of dehydrated food—Ministry of Labour and National Service, Central (T and S) Register, Room 5/17, Sardinia House, Kingsway, London, W C 2, quoting F 3854 A (June 20).

TWO CHEMISTS (Technical Officers) in the Infestation Division the Ministry of Food—Ministry of Labour and National Service, Central (T and S) Register, Room 5/17, Sardinia House, Kingsway, London, W C 2, quoting F 3874 A (June 20).

INSTRUCTOR AND LECTURER ON INDUSTRIAL CHEMISTRY at the National Fire Service College, near Brighton—Ministry of Labour and National Service, Central (T and S) Register, Room 5/17, Sardinia House, Kingsway, London, W C 2, quoting F 4165 A (June 20).

LECTURER IN CHARGE OF THE DEPARTMENT OF ZOOLOGY, University College, Leicester—The Registrar (June 20).

ASSISTANT LECTURER IN PHYSICAL AND INORGANIC CHEMISTRY at Queen Mary College, University of London—Acting Registrar the College, c/o King's College, Cambridge (June 20).

LECTURER IN AGRICULTURE AND FARM MANAGER at Harper Adams Agricultural College, Newport, Shropshire—The Principal (June 20).

LECTURER IN BIOCHEMISTRY for the Yaba School of Medicine, Nigeria—Ministry of Labour and National Service, Central (T and S) Register, Room 5/17, Sardinia Street, London, W C 2, quoting F 4082 A (June 21).

LECTURER IN CIVIL ENGINEERING in the University of Birmingham—The Secretary (June 23).

PRINCIPAL OF NEWTON HEATH TECHNICAL SCHOOL—The Director of Education, Education Offices, Deansgate, Manchester, 3 (June 2).

LECTURER IN BUILDING SCIENCE at the Huddersfield Technical College—The Director of Education (June 25).

PROFESSOR OF PHYSIOLOGY at King's College of Household and Social Science—The Academic Registrar, University of London, Richmond College, Richmond, Surrey (June 26).

CO-ORDINATOR OF RESEARCH AND PRINCIPAL OF THE PUNJ AGRICULTURAL COLLEGE, LYALLPUR—Ministry of Labour and National Service, Central (T and S) Register, Room 5/17, Sardinia Street, London, W C 2, quoting F 4220 A (June 26).

READERSHIP OF ENTOMOLOGY in the University of Durham, tenable at King's College, Newcastle-upon-Tyne—The Registrar of King's College (June 30).

INSTRUCTOR-ORGANIZER FOR MINING EDUCATION under the Shropshire Education Committee—The Secretary for Education, Courthouse Buildings, Shrewsbury (June 30).

LECTURER-IN-CHARGE (female) OF THE HOME SCIENCE DEPARTMENT, Technical Education Branch, Education Department, Sydney Acting Official Secretary, New South Wales Government Offices, 1 Strand, London, W C 2 (June 30).

UNIVERSITY DEMONSTRATOR IN ENGINEERING, University of Cambridge—The Secretary of the Appointments Committee, Engineer Laboratory, Cambridge (July 2).

ASSISTANT EDUCATION OFFICER FOR TECHNICAL EDUCATION to the Hertfordshire County Council—The County Education Officer, Courthouse, Hertford (July 3).

TWO LECTURERS IN THE DEPARTMENT OF PHYSIOLOGY, one with special knowledge of Experimental and Human Physiology, and other with experience in Biochemistry, University of Aberdeen. The Secretary (July 7).

ASSISTANT with special knowledge of PHYSICAL or INORGANIC CHEMISTRY in the Department of Chemistry, University of Aberdeen—The Secretary.

LECTURER IN HYGIENE at Derby Training College for Women Teachers, 93 Uttometer New Road, Derby—The Principal.

LECTURER IN MECHANICAL ENGINEERING, and a LECTURER IN MATHEMATICS OR SCIENCE, at Birkenhead Technical College, Birkenhead, Kent—The Principal.

A SENIOR OFFICIAL OF THE INSTITUTION OF STRUCTURAL ENGINEERS—The Secretary, 11 Upper Belgrave Street, London, S W 1, mark the envelope "Science".

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CONTROL OF SCIENCE IN GERMANY

ON two successive days, May 29 and 30, Lord Cherwell was called upon in the House of Lords to reply on behalf of the Government to inquiries dealing with the control of scientific development in Germany, with special reference to applications in warfare. Such inquiries are evidence of the keen interest which is being taken in this topic, and should be welcomed since they made it possible to give authoritative assurances and also dispose of some of the more alarming apprehensions of which we have heard so much in the past few months.

The first inquiry, general in character, came from Lord Vansittart. He said that unless strict control be maintained over scientific developments in Germany, there will inevitably be developed even more potent 'secret' weapons than those from which we suffered in recent months. Provision should also be made to guard against other countries, whether Allied or neutral, granting Germany permission to use devices developed by them which were potentially dangerous. He therefore advocated the control of all German laboratories, university and industrial, through an extensive and intensive intelligence service provided from the United Nations. In addition, Lord Vansittart suggested the formation of a civil inspectorate, which might in time become a world inspectorate on the watch for the development or over-development of secret devices likely to be turned against mankind. Without some such safeguard, he predicted that nations would quickly become involved in a secret armaments race more terrifying than any previous such race. Lord Vansittart therefore asked the Government to take the initiative in proposing the inclusion in the terms to be imposed on Germany of an article providing for an inter-Allied committee of scientific men to examine and control, and if necessary prohibit, the use by Germany of any scientific invention or discovery considered likely to be dangerous to the safety of mankind.

Lord Strabolgi supported this view, and suggested that similar action should be taken against Japan. Incidentally, he suggested that Lord Vansittart gave the impression that it was the discovery of new weapons which makes wars. This would put the responsibility for war on scientific men and inventors, this, as Lord Strabolgi commented, is incorrect. The worst that can be said of men of science in this connexion is that they are coerced or persuaded or bribed into helping the real war-mongers.

The second inquiry, more specific in character, came from Lord Brabazon, who discussed particularly the so-called directed missiles, the flying bomb and the rocket. The engine of the flying bomb, he said, developed 350 h.p. and cost about £15, while the rocket is capable of immense development—"the physicist's dream or nightmare." He believes that the policing of Germany will be relatively easy for ten years, after which troubles will begin to arise. The technique of rocket propulsion is bound to develop, and he drew a vivid picture of a future power secreting long-range rocket weapons, with new

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explosives and new powers of control, and unleashing them swiftly against the great cities of its enemy with terrible effect before armies could be assembled. He therefore suggested the constitution, as a part of the peace organization, of an international committee of inspection with power to enter works anywhere in the world. There are, he said, only two alternatives to push on vigorously, in combination with the United States, the development of this technique in order to obtain a lead over the rest of the world, or to invent such machinery of inspection as may be necessary to prevent development.

The story was taken up by the Earl of Darnley, who painted a gruesome picture of the war of the future, in which the fighters would be bands of troglodytic alchemists dealing out death to millions. He also referred to the atomic bomb, which he said was almost ready at the end of the War. Any future war might last only a few minutes, and might end before survivors knew what had happened. The development of such engines of war would lead to the extermination of the human race. Lord Darnley's address reminded one of H. G. Wells' "War in the Air", revised and with a modern setting.

Lord Cherwell's replies set out the Government's policy and also provided a survey in general terms of the problem of secret weapons and related topics. He said that the Government appointed a committee of scientific men a year ago to consider the whole question of the future of scientific research in Germany, and that a report of its preliminary conclusions will shortly be ready, "the Government," he said, "will certainly give the greatest weight to them." Any proposals, however, must be discussed with our Allies, and a concerted policy agreed upon. A scientific and technical staff has been attached to Supreme Headquarters of the Allied Expeditionary Forces for some time, the duties of which have been the examination and control of German activity in these fields. All German activities, including scientific work, will come under the Control Commission. It would be premature, in the Government's opinion, to make specific proposals for inclusion in any eventual peace treaty. He assured the House, however, that the Government intends to see that scientific men will continue to play their part both in disarming Germany and securing the future against the use of scientific developments by that country for war-like purposes.

In discussing the general problem of secret weapons, Lord Cherwell gave a well-balanced account of the approach from a scientific point of view. The problem is a grave one, as he admitted, but spectacular or unexpected results must not be allowed to outweigh the conclusions of careful investigation. In the first place, Lord Cherwell said that a distinction should be drawn between pure science and its applications, in the former, the Germans are definitely behind the leading Allied nations, in the latter, they have maintained a high reputation, due largely to their methods of training. But the new German weapons of war, while they were well-executed pieces of engineering designed for a particular purpose, did not involve any new scientific principle. Radio-

location is an application of the experimental fact known for the past fifty years, that a metal object scatters electromagnetic waves, and many nations including the Germans, applied themselves to its development as a means of detecting aircraft at night. German engineers produced a workable method, but it was not so efficient as that developed in Great Britain.

Dealing with Lord Vansittart's suggestion for an international scientific committee for the investigation of developments in German laboratories, Lord Cherwell pointed out the difficulty of deciding at what stage a scientific discovery might be considered likely to be potentially dangerous in unscrupulous hands. Thus, in the investigation of electromagnetic radiation, supposing such a committee had been in existence when their existence was predicted by Clerk Maxwell, would it have been able to act immediately? Or would it have deferred action until Hertz detected the radiation a few years later, or when Marconi demonstrated its commercial use, or when broadcasting was in its infancy? Another example quoted by Lord Cherwell to emphasize his contention was the discovery by Elster and Geitel that a negatively-charged plate of zinc loses its charge when ultraviolet light impinges on it. This effect is the basis not only of the talking film, but also of modern instruments for measuring the velocities of shells and bullets. Indeed, it is a truism to say that no one can foresee all the possibilities of a scientific discovery, and Lord Cherwell clearly does not believe that an international committee of investigation would be of much value. Nevertheless, as has been said above, he stated that the Government intends to pay adequate attention to scientific aspects of control.

Lord Cherwell re-affirmed this point in his reply to Lord Brabazon, before passing on to deal specifically with the question of long-range weapons. He pointed out that range is not the only consideration in warfare. The R.A.F. produced a pilotless aircraft some years ago, he said, but development was stopped because it was found that the weapon was not accurate enough to hit the kind of targets which we were likely to be concerned. London is a unique target with about 700 square miles of built-up area and within a hundred miles of a foreign coast-line, and the Germans considered it worthwhile to attempt the kind of random bombardment which the use of such weapons involves. The only guided missile described during the War was the wireless-controlled glider bomb used by the Germans against shipping.

Some interesting figures were given by Lord Cherwell about the cost of production of long-range weapons. He equated one bomber to a hundred 'flying bombs', and bearing in mind that the range of the latter was about 140 miles and its accuracy less than a tenth of that of a bomber, it was clearly an uneconomic weapon. The rocket, V2, is believed to be even more uneconomic, for Lord Cherwell said that it probably cost twenty times the number of man-hours to produce. Granting that the bombardment with flying bombs and rockets caused mu-

suffering, they can only be used against a target area of large dimensions, and the cost of production in man-hours can generally be spent to more effect on the manufacture of bombers. The total weight of the war-heads of flying bombs which crossed the English coast during three months was less than 6,000 tons, and about half of these bombs reached the London area, in seven months of bombardment by rockets, about 1,000 tons of war-heads reached England, and only about a half reached London. Against such figures can be put the facts that the R.A.F. was able to drop nearly 5,000 tons in a single attack, in many cases with half of the bombs within a mile of the target, and that the attack could be launched on any city in Germany.

If, however, the anti-aircraft defences of a country could be developed to the point when it became exceedingly dangerous for bombers to fly over it, then there would be a case for long-range weapons at the very length of range militated against their accuracy. The only means known at present of guiding such missiles to their targets is radio, and very elaborate anti-jamming devices would be essential. Moreover, the greater the distance from the launching point, the greater the efficiency of jamming, half-way along its trajectory, the guiding transmitter and the jamming devices might have equal power, but at three-quarters of the distance or range, the jamming might have a ninefold superiority, and so on.

Lord Cherwell also referred to the possibility of utilizing atomic energy. He stated that there has never been an instance of the experimental disintegration of an atom without a collision of one of the bombarding particles and the nucleus of an atom, and there is no reason to think that the disintegration would extend to ordinary matter, thus bringing about the explosion of the whole earth. Nevertheless, Lord Cherwell said that unless the nations could agree on some form of limitation of weapons, their range and lethality would undoubtedly increase, and we in Great Britain have the most to lose by this. He therefore insisted that, until an international organization can guarantee our safety, we must keep ahead in all scientific and technical advances of warfare, and the Government would spare no effort to do so.

Lord Cherwell's statements will be widely welcomed. They dealt with the question of the 'terror' weapons used by Germany against the background of warfare in general and bombing by piloted aircraft, demonstrating effectively the relative superiority of the latter for large-scale effects. Nevertheless he concluded the possibilities of development, to guard against which intense scientific effort will be necessary. As will apparently take two forms: the strict control of German laboratories, and increased activity on our own. But the first step will be consideration of the report of the scientific committee discussing scientific research in Germany. It is to be hoped that the general conclusions of this committee, if not the whole report, will be made available for discussion, for it will be a document of the greatest interest to scientific workers.

MEDIEVAL ORNITHOLOGY

The Art of Falconry

Being the "*De Arte Venandi cum Avibus*" of Frederick II of Hohenstaufen. Translated and edited by Casey A. Wood and F. Marjorie Fyfe. Pp. 6x+637 (186 plates). (Stanford University, Calif.: Stanford University Press, London: Oxford University Press, 1943.) 60s. net.

IT will scarcely be questioned that this work of the great Roman Emperor, the founder of the University of Naples in 1224, is one of the most remarkable scientific documents which have come down to us from the Middle Ages. Having said this, it is astonishing to have to add that the present edition is the first appearance of the complete work in print in any language. We owe this tardy recognition to the devotion and learning of the senior translator, Dr. Casey Wood, the founder of the Wood Library of Ornithology at the McGill University, Montreal. The fact that there is a widespread revival of interest in Frederick's researches in ornithology is the achievement of another distinguished American scholar—the late Prof. C. H. Haskins. What is needed now is the publication of a standardized Latin text collated from all the known manuscripts, but the task would be long, arduous and costly.

The first printed version of 1596 in Latin is by Marcus Velser and is based on the incomplete Vatican manuscript. It includes only Book 1 and the first thirty chapters of Book 2, and also lacks nine chapters of Book 1. These missing chapters, however, are to be found in the thirteenth-century Bologna manuscript, which is the earliest version of all six books, and was therefore (in conjunction with the Vatican manuscript) employed as the chief source of the present translation. The second Velser edition of 1788–89, by the zoologist J. G. Schneider, is particularly valuable on account of the commentary and notes of its distinguished editor. Both these Latin texts are exceedingly rare, especially the latter. The only other printed editions are two German translations of Velser's text.

It is generally agreed that Frederick is the author of the original work, and he may even have been its scribe and illustrator. It was written after some thirty years of preparation between 1244 and 1250, and it terminates abruptly at Chapter 34 of Book 6. He mentions his intention of writing a section on the diseases of birds, which, if written, has not survived, and as he himself died in 1250 it seems certain that the work was never completed.

The present volume includes an annotated, illustrated English translation of the complete Latin text, based on a comparison of the twelve available manuscripts in European libraries, a chapter by the English zoologist Cresswell Shearer on the castles and hunting lodges of the Emperor, appendixes on various topics of practical and historical importance to falconers, an annotated list of the birds mentioned and figured by Frederick, and an admirable critical bibliography of ancient and modern falconry, together with a glossary and index. The book is lavishly illustrated, and the Stanford University Press has demonstrated that typography of the highest class is still possible in America in war-time.

The Emperor stands out from his contemporaries as an original thinker and observer. The methods of the scholastics, which at that time were coming into dangerous prominence, were rejected, and he saw

that science could advance only by research. Shearer rightly claims that the "De arte venandi" is the "first zoological treatise written in the critical spirit of modern science". Thus, for example, the barnacle goose myth is methodically investigated by Frederick, and dismissed as a superstition based on ignorance of the real nesting places and fledglings of this bird, but none the less the superstition survived until the eighteenth century*. Nor does the Emperor confine his studies to the falcons used in hunting. He is interested in birds generally, and his work must be regarded as the first generalized treatise based on original investigation of the species, habits and structure of birds. His philosophical outlook is that of the teleologist, who interprets adaptations as evidence of an ordered and designed world into which the peculiarities of avian structure must, and can, be fitted in.

The part of Frederick's work relevant to the interests of this journal is Book I, which deals with the biology and anatomy of birds, especially, but by no means entirely, of the species employed in hunting. Particular attention is devoted to external characters, habits of feeding, reproduction, and locomotion in all its forms. A comprehensive account is given of plumage, how and when it is moulted and the different types of feather, with their distribution over the body and their functions in the general economy of the bird. The *ala spuria*, with its four *plumæ pollicis*, is described. He mentions, and evidently saw, a single bone only in the *ala*, but the present translators render this passage in the plural, which is correct as a statement of fact but is not what the Emperor wrote. Frederick's views on the function of this part are fanciful and strange even for his own time.

The Emperor's discussion of his researches on the problems of bird migration is admirable and detailed, although he could not be expected to have deduced or guessed the historical setting of avian migration. He distinguishes several geographical and climatic types of the phenomenon, and he also perceives that the colder of the two climates inhabited by a migratory bird, namely, that in which it nests, must be regarded as its original home. His anatomical notes, if somewhat scanty, include some interesting and acute observations. He describes the nictitating membrane of the eye—previously, however, known to Aristotle—and appears to have seen parts of the osseous labyrinth of the ear. His account and interpretation of the skeleton of the wing is on the whole sound, but his *tour de force* is a comparison of the skeleton of wing and leg. Here, basing his conclusions on the limb skeletons of various birds, he correctly homologizes, and for the first time, the bones of the leg, and avoids the pitfall of regarding the tarso-metatarsus as the shin bone. Other features in the anatomy of birds known to Frederick are the muscles of flight, the distinction between the stomachs of carnivorous and graminivorous birds, the uropygial gland, the sinus rhomboidalis of the spinal cord and ventricles of the brain, the hyobranchial apparatus, the absence of an epiglottis, the aperture of the Eustachian tubes, the absence of the gall bladder in some birds and of the urinary bladder in all, and the fact, known to Aristotle, that the rectum and urogenital ducts open into a common chamber or cloaca. The Emperor also describes the looping of the trachea in the sternum

of the crane, which he associates with the production of the deep call of this bird, and he noted that the pairs of spinal nerves emerged from the backbones between contiguous vertebrae.

We have checked the translation against Velser's printed text only in those cases where the rendering was obviously open to question. Even this, however, could not always be done, owing to imperfections in the Vatican manuscript which was the version transcribed by Velser. The statements that "sterile eggs lack the activating male spermatozoa" and that impulses are carried to all parts of the body by "motor and sensory nerves" scarcely suggest an original written in the thirteenth century. The "vaginae deferentes" are obviously the ureters, and not the uriniferous tubules, which Frederick could not possibly have known. In Chapter 44 the translators imply that the Emperor described a pair of ovaries in birds, whereas he distinguishes between the sexes by using the plural in his account of the male, and the singular in that of the female. It is clear that he was familiar only with the functional left ovary and oviduct present in most birds.

Dr Casey Wood did not live to handle the beautiful volume he had wrought so hard, and for so long, perfect, but the work itself remains as a lasting monument to his memory. F. J. COLE

MEDICINE IN THE TROPICS

Tropical Medicine

By Sir Leonard Rogers and Sir John W. D. Megaw (Churchill's Empire Series). Fifth edition. Pp. x + 518. (London: J. and A. Churchill, 1944.) 21s.

A GOOD indication of the value of this book is the fact that five editions of it have appeared since 1930 and that two editions have been required since the third edition in 1939. Originally the book was written for the general practitioner in the tropics rather than for the specialist with up-to-date laboratory facilities at his disposal. The aim of the author was to provide a small and handy book which would give a broad survey of the field of tropical medicine and yet would deal adequately with the diagnosis and management of diseases commonly encountered in the tropics and subtropics, with such methods of microscopical study and laboratory diagnosis as the general practitioner could carry out by himself. Such a book could only be written satisfactorily by an author with wide experience of the practice of medicine in the tropics who also had the power of communicating their experience to others and the judgment necessary for the wise selection of the essentials.

It would be difficult to find anyone who possesses these qualities in greater degree than do Sir Leonard Rogers and Sir John Megaw. They have produced a volume which is both a general introduction to this fascinating subject and a practical guide of great value. It is likely to have greater value in the future for the wide dissemination of Allied troops in tropical countries during this War carries with it a risk of the spread of tropical diseases both to areas within the tropics and sub-tropics and to non-tropical countries. The control of this risk has already required the creation of a considerable organization, and in the control the general practitioner must play an essential part. As the authors of this book point out, successful treatment of tropical diseases—and indeed of

* In his fascinating book on the barnacle goose, Heron-Allen states that Frederick does not mention the myth, but this is an error traceable to the printed text which lacks the chapter in question.

lises—depends upon early diagnosis, and prevention of them is no less dependent on this. The general practitioner therefore mans the front-line observation post upon which the artillery of preventive medicine relies. He will find in this compact and authoritative volume an invaluable source of the accurate information which he must have.

In this fifth edition no change has been made in the plan and scope of the book, its size has not been increased, it is, in fact, a few pages smaller, but many pages have been entirely rewritten, especially the chapters on malaria, kala-azar, trypanosomiasis, the fevers of the typhus group, leprosy and the dietetic diseases. Although the results of much modern work have been included, the book evidently went to press just too early for the inclusion of any reference to the remarkable success of D D T for the control of the lice which transmit epidemic typhus fever (cf *Nature*, 154, 600, 1944). Possibly much more information than can at present be released about the uses of D D T will be available for a post-war edition in which it will, we may hope, be possible to include so valuable data obtained during the War which is not yet available for general publication. The possible value of penicillin for the treatment of typhus fever and other Rickettsial diseases is mentioned in the addendum on the treatment of louse typhus at the end of the book. Incidentally, the chapter on the febrile diseases caused by Rickettsia bodies is one of the most clearly stated short accounts that we possess of the essential differences between epidemic and endemic, louse-borne typhus (including Brill's disease) on one hand and, on the other, the non-epidemic, zootic typhus fevers (murine endemic sea-borne typhus, tick-borne Rocky Mountain spotted fever, the mite-borne Japanese river fever which is also called tsutsugamushi or scrub-typhus and the other types of tick-borne and mite-borne fevers which resemble typhus).

The section on dietetic diseases is introduced by a chapter on dietetic errors in the tropics which should be read by all who contemplate going there. These chapters on the dietetic diseases and the chapter on the effects of such climatic factors as sunlight and heat, with the wise advice given on the methods of combating the tropical climate by means of clothing, modern methods of cooling and so on, should enable visitors to the tropics to avoid lowering their resistance to tropical disease or becoming victims of the direct action of climatic factors themselves. Only those who have lived in the tropics can appreciate the importance of this kind of personal and general hygiene. Another valuable chapter, by Sir Leonard Rogers, compares the incidence in Calcutta and London of general diseases which are encountered all over the world, so that the reader can form an idea of what he is to expect apart from tropical diseases themselves. The importance in the tropics of these non-tropical diseases is often underestimated. The extreme importance of the problem of tuberculosis in India, for example, has been only recently realized. Sir John Megaw adds a section which amplifies the conclusions drawn by Sir Leonard Rogers. He discusses beriberi, pellagra, and nutritional anemias, endemic dropsy and other conditions due to faulty nutrition. One small paragraph in this section reveals a need for vigorous action for the betterment of the nutrition of tropical peoples. Dietetic malnutrition, Sir John considers, is the most important of the tropical diseases. It causes lifelong disablement of hundreds of millions of people, and is indirectly

responsible for millions of deaths every year. It is so common in some parts of the tropics that it is regarded as the normal condition of the people. The extensive planning of world civilization in the future which is now going on should make sure of the removal of this kind of underlying cause of disease. It is, as the careful rationing system in Britain during this War has shown, by no means confined to the tropics.

Many general practitioners will find useful the final chapters on the use of the microscope and on diagnosis. If they add to this book the study, suggested by its authors, of the *Tropical Diseases Bulletin*, they should be well supplied with up-to-date information. For the abstracts of world literature printed in the *Tropical Diseases Bulletin* are unique in that they are the critical work of experts, among whom are the authors of this book, so that they form a supplementary text-book which is continually being brought up to date.

G. LAPAGE

CHEMISTRY OF MILK AND MILK PRODUCTS

A Textbook of Dairy Chemistry

By Edgar R. Long. Second and revised edition. Vol. 1. Theoretical. Pp vii+196. (London: Chapman and Hall, Ltd., 1944.) 13s. 6d. net.

JUNIOR students of dairy science are at present ill-provided with competent, up-to-date textbooks. The War has doubtless been responsible for the lag in getting the results of the considerable advances of recent years into a form useful for the younger student.

In dairy chemistry the situation is now much easier than in dairy physiology or dairy husbandry. We have the thorough revision (1942) of Richmond's "Dairy Chemistry" by Elsdon and Walker, a valuable text with a strong analytical flavour, and now the volume under review, written by one of our most experienced teachers of agricultural chemistry. The present edition is a fairly complete revision of the theoretical part of his 1930 volume.

It is a straightforward, sensible handbook for students of intermediate grade, is well documented and demands no more than a fair elementary acquaintance with chemistry. Careful thought has clearly been given to providing a simple yet accurate, readable and up-to-date presentation.

Nevertheless, in one or two places revision has faltered. The table on p. 55 purporting to show the vitamin content of various types of milk and dairy products certainly requires overhaul. Instead of indicating vitamin content by vague adjectives such as 'good', 'fair', 'slight', etc., use should be made of the range of quantitative data now available (in μgm or in international units) for most, though not yet all, dairy products. One could also have wished that the paragraph on the effect of heat on milk had been brought closer to date and that recent sources had been quoted, though the author does in fact reach the right conclusion in his final sentence (p. 109). These small blemishes are perhaps the more evident since the background is generally so well informed.

The book can confidently be recommended to dairy diploma students and to those engaged in the dairy industry who require a sane and dependable chemistry text-book.

H. D. KAY

Catalogue of Lewis's Medical, Scientific and Technical Lending Library

Part 1 Authors and Titles, Part 2 Classified Index of Subjects, with Names of Authors who have written upon them. New edition, revised to the end of 1943. Pp. xiii+928 (London: H. K. Lewis and Co., Ltd., 1944). To Subscribers, 12s 6d net, to non-Subscribers, 25s net.

THE difficult task of cataloguing the great variety of scientific books in this remarkable library has been well done. Probably the most difficult part of it was the compilation of the subject index (Part 2). This section indicates the wide range of the library, for the headings in it extend from chemistry (9½ pages) to travel, and from sugar to suicide. It covers, in fact, practically the whole range of science. Together with the alphabetical list of subject headings, it forms a valuable reference list of the authors of important works on the various branches of science up to the end of 1943. Subscribers receive, each month in normal times and quarterly at present, lists of new books and editions added to the library, which keep them in touch with new publications.

It is not surprising that "Lewis's" is used by scientific workers of very varied interests and by book clubs, medical and scientific societies and by the research departments of many industrial organizations. The preface to this catalogue suggests that we owe the foundation of "Lewis's" to Carlyle, whose complaints about the loss of time involved in waiting for books at the British Museum gave us the London Library as well, so "Lewis's", originally mainly medical, came into being and now provides a unique general science library service which has features no other scientific libraries possess. The subscriber will not, however, be able to borrow scientific books in foreign languages, unless these have been translated. Many subscribers have hoped, and still hope, that it will eventually be possible to remove this restriction.

It is never easy to assess in a few words any library service. So much depends upon atmosphere, the spirit of service and the willing co-operation of the borrower in seeing that the necessary rules are obeyed. But the long experience and wise management of "Lewis's" have surmounted the potential causes of complaint and failure. This catalogue is, incidentally, a tribute to their quality as publishers. It is yet another example of the high degree of attractiveness, utility and good printing which can be attained under the authorized economy standards of war-time book production.

The Natural Order

Essays in the Return to Husbandry. By Edmund Blunden, H. J. Massingham, B. D. Knowles, Philip Mauret, Philip Oyler, L. F. Easterbrook, C. Howard Jones, J. E. Hosking, Lord Northbourne, Michael Graham, Rolf Gardiner, Adrian Bell, C. Henry Warren, the Earl of Portsmouth. Edited, with an Introduction and Notes, by H. J. Massingham. Pp. vi+178 (London: J. M. Dent and Sons, Ltd., 1945). 7s 6d. net.

THIS volume, containing some fourteen essays, has been written by lovers of the country, its agriculture, rural tradition, and way of life. No doubt it will be read with pleasure and approbation by those of kindred mind. It *should* be read seriously by a much wider section of the community, in particular by those who, by political action, mould

the national way of life. It may be argued, of course, that there is a sense in which everything that man does is part of the natural order. But the meaning intended is made quite clear in the introduction and in the integrated series of essays presented. The basic plea is for a return to good husbandry, for a personal understanding of the land, and a knowledge of how it should be used so that its fertility may be conserved and used to best advantage; it is a plea for good work performed for its own sake and because it is part of a good way of life; it is a plea for the retention of a civilization that is rapidly being submerged in the modern mechanized, urbanized development; above all, it is a plea for the fair treatment of the land (and those who work on it) or which so much that is good in our national life depends. The theme is fully explored in essays contributed by authors each with particular experience of his own subject. Here and there, no doubt there are evident overstatements, and occasional pseudo-scientific assertions which would have been better omitted. But these can well be overlooked in a book that is so unmistakably sincere. More is the pity that so much that could be ideal in life is unlikely to be realized.

The British Journal Photographic Almanac and Photographer's Daily Companion

With which is incorporated the Year Book of Photography and Amateurs' Guide and the Photographers' Annual, 1945. Edited by Arthur J. Dalladay. Pp. 388+31 plates (London: Henry Greenwood and Co., Ltd., 1945). Paper, 3s 6d net, cloth, 5s net.

THE "British Journal Photographic Almanac" is one of those books that few photographers can afford to be without. This applies to all those who handle cameras or photographic materials, whether they be amateurs or professionals, interested in pictorial photographs or research involving the use of light-sensitive materials. The volume is published annually and, while much of the contents is little changed from year to year, a series of up-to-date articles forms an important feature of each issue. This year there is an editorial which deals with the development of photography from the days when a photographer started by serving an apprenticeship to learn the technique, until to-day when photography is being used more and more for scientific purposes where a knowledge of the behaviour of photographic materials is a necessary preliminary. The plea is for the professional photographer of the future to learn more of the science of photography and rely less on rule of thumb methods. Is it not even more important that the would-be research worker should be taught more of the science of photography so that he can should the need arise, use photography intelligently as a tool to assist his research?

Other articles of interest are "Photograph Dermatitis" in which the requirements of preventive treatments are considered and formulae given for various preparations, "Colour Photography Practice" deals with the pre-war, war and post-war periods in the principal countries, mainly from the point of view of the commercial and advertising trade, "pH Measurement by Indicators" is written for photographers and deals with the subject from the point of view of photographic solutions. The remainder of the volume is taken up by formulae, general information, advertisements and illustrations etc., so well known to those familiar with previous issues of the almanac.

ISOLATION OF THE MAMMALIAN COLOUR RECEPTORS WITH MICRO-ELECTRODES

By PROF. RAGNAR GRANIT

Nobel Institute for Neurophysiology, Karolinska Institutet, Stockholm

IN 1943 I gave a summary¹ in *Nature* of my analysis of the retinal colour receptors isolated with micro-electrodes on the optic nerve reached from the inside of the opened bulbs of various light-adapted animals, anesthetized or decerebrated. Two types of responses were found to be represented by single fibres: narrow bands of sensitivity located in three preferential regions of the spectrum, 0.600–0.580 μ (red-yellow), 0.500–0.540 μ (green) and 0.460 μ (blue). These were called *modulators*. In addition, there was a broad band, called the *dominator*, with maximum at 0.560 μ , and a distribution of sensitivity corresponding to the human photopic luminosity curve. The dominator was held to mediate the sensation of white. The modulators were located by a 'chance method' of surveying a large number of light-adapted retinæ. It seemed desirable to check these results by devising a method for removing this element of chance, and at the same time to find out whether the dominator could be regarded as the sum of a number of modulators. To this end a method of selective adaptation was employed. The new results obtained will now be briefly summarized. They represent my general solution of the problem and have confirmed and extended the earlier results.

Decerebrated cats were used as experimental animals. A special colorimeter, designed by Dr D. Wright of the Imperial Institute of Science and Technology, on the principles of his own well-known instrument², and constructed by Mr G. C. Ewton, was used for stimulation. In such experiments the micro-electrode records the impulses from convergence unit of the type shown to the right.

Fig. 1. There are connected to the same optic nerve fibre receptors which contain merely visual purple and receptors containing other colour-sensitive substances. The number of receptors is probably

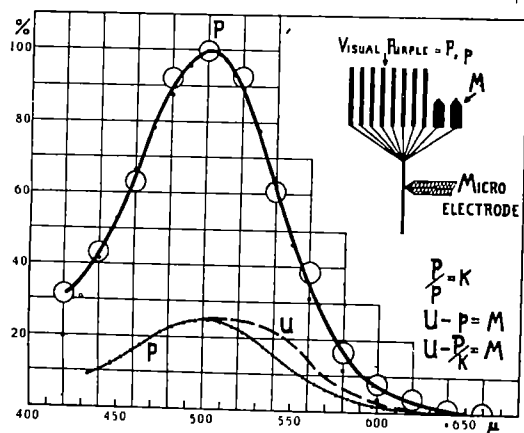


Fig. 1. MICRO-ELECTRODE RESULTS FOR DARK-ADAPTED CAT. Large circles, averages for spectral sensitivity of dark-adapted cat's retina. Small black circles, Lythgoe's³ corrected curve for visual purple absorption. For significance of symbols and p - and i -curves, see text. Spectrum of equal quantum intensity diagram to the right illustrates convergence element picked up by micro-electrode on the optic nerve.

very much larger than in the diagram and the proportion of the two types is unknown and variable. In the dark-adapted state the highly sensitive visual purple completely dominates the results and gives the curve P (Fig. 1), based on some 1,320 readings, averaged into 179 values, again averaged to give the large circles around the curve. The small black points are Lythgoe's³ corrected curve for visual purple absorption, which is a little too low in the violet, as shown by Schneider, Goodeve and Lythgoe⁴. A slight effect of the dominator makes my curve a little too high in the yellow-red region.

If the eye be adapted to red, blue or green light, the curve P is reduced to p , by proportionate ordinates at all wave-lengths, since P represents a homogeneous substance. Hence

$$P/p = k \quad (1)$$

But if there are any other colour-sensitive substances (M), preformed or produced by visual purple, curve P does not drop to p but to some other curve U (Fig. 1). The modulators M are given by the difference between U and p , as evident from the diagram, or

$$M = U - p \quad (2)$$

In this case p is unknown, but the equation can be solved by giving it the form

$$M = U - P/k \quad (3)$$

P is obtained before, U after, selective adaptation, and k can be obtained from (1) by finding the spectral region in which selective adaptation has caused the largest drop of sensitivity, since in this region there was no substance other than visual purple to resist adaptation. This region will generally be found in the place where the letter p is inserted in the diagram (Fig. 1). All quantities of (3) are now known and the argument can be tested by experiment.

Equation (3) was solved in thirty-four experiments on the basis of some four thousand observations collected in 601 points on U -curves. Some 60 per cent of the U -series referred to isolated fibres, the rest to restricted activity. In 29 per cent the equation came out zero ($U = p$) and hence the micro-electrode had struck a unit with pure visual purple receptors. In the rest of the series the characteristic narrow modulator bands of sensitivity were obtained. Red adaptation gave green and blue modulators (the red ones wholly suppressed), blue adaptation merely red modulators, green adaptation gave red, blue and green modulators.

The averaged modulators are shown in Fig. 2, in which the outer contours indicate the dispersion. The narrow red modulators were of two types with maxima at 0.600 μ (red) and 0.580 μ (yellow) respectively, the former type more common. Most green modulators overlapped and had maxima at 0.540 μ , some at 0.520 μ , and two of them were of the type previously described as narrow visual-purple curves. These may be lacking in pure cone eyes. All these modulators have been seen before in different types of retina, analysed by the earlier 'chance' method¹. Most blue modulators had their maxima at 0.460 μ (blue), one at 0.440 μ (violet). They were very narrow bands. Errors of measurement increase from red to the blue end. On account of the steepness of the modulator curves the maxima are fairly well definable.

The averaged modulators of Fig. 2 are too narrow to add up to a cat dominator. It is clear that impulses also must be delivered up the optic nerve by modulators with 'legs' outside the averages. The

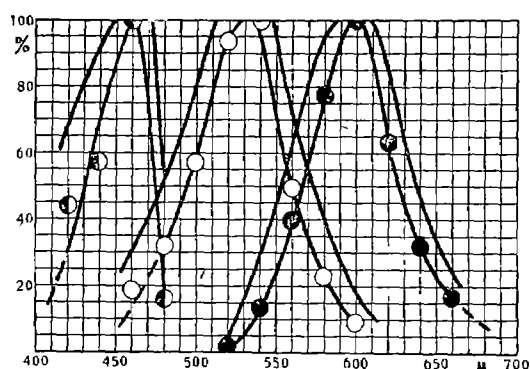


Fig 2 AVERAGES OF INDIVIDUAL MODULATORS IN THE THREE PREFERENTIAL REGIONS. Outer contours indicate dispersion. Spectrum of equal energy.

greater the number of modulators added, the greater has to be the spectral area allotted to each preferential region. In Fig 3, I have synthesized the cat's dominator, as obtained experimentally with single fibres some years ago⁵. This has a hump at 0 600 μ . The circles refer to the readings, the thick line to the theoretical curve obtained by adding the R and G curves. It is a remarkable fact, demonstrated by Wright⁶, that if the human photopic luminosity curve be determined with a sufficiently small stimulus, imitating the micro-electrode recording, it too has a hump around 0 600 μ , and, in fact, fits my synthesized curve for the cat almost exactly.

In Fig 4, I have synthesized the human photopic luminosity curve with three 'fundamental sensation curves' for R, G and B, and indicated the red and yellow modulators adding up to the R curve. These fundamental sensation curves correspond fairly well to those recently obtained by Walters⁷ on the human eye. In his work will be found a summary of the earlier attempts to define the fundamental sensation curves.

Now these fundamental sensation curves do not exist, except as mathematical entities. Nature uses a six- or seven-colour mechanism made up of narrow modulators, two red, two blue, two or three green. In addition, many of these modulators form fixed groups responding as *functional units* with the [dominator distribution of sensitivity. Despite considerable

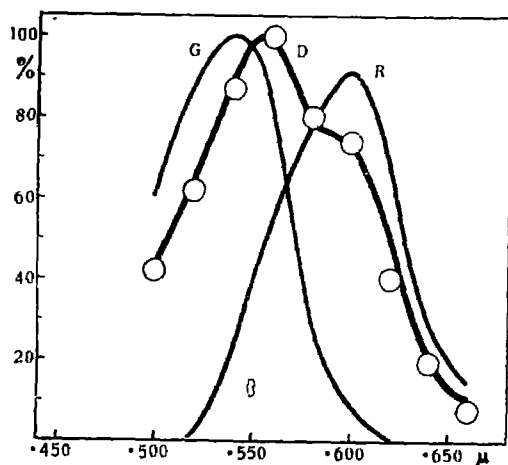


Fig 3 CIRCLES, AVERAGES OF FOUR PHOTOPIC DOMINATORS OF CAT. Curve D, synthesis of cat dominator by adding grouped modulators in the red (R) and the green (G) and plotting their sum in per cent of maximum. Spectrum of equal energy.

experience in recording from single fibres, I have never seen three 'fundamental sensation curves', but merely dominators and the narrow modulator localized at the three preferential regions. The trichromatic theory is therefore to be regarded as a convenient first approximation expressing the spectral areas covered by the three groups of modulators in terms of gross averages.

The existence of families of modulators, located in three preferential spectral regions, makes the extraordinary capacity of the eye to discriminate colour intelligible. In Fig 5, Wright and Pitt's⁸ measurements of colour discrimination are found. These show maxima of discrimination (minima in the curves at 0 580-0 600 μ , where the red and yellow modulators overlap and intersect with the green ones, at 0 480-0 510 μ , where the red, green and blue modulators intersect and rise, as well as at 0 450-0 440 μ , suggesting that two blue modulators, the blue proper and the violet one, overlap in this region, as also

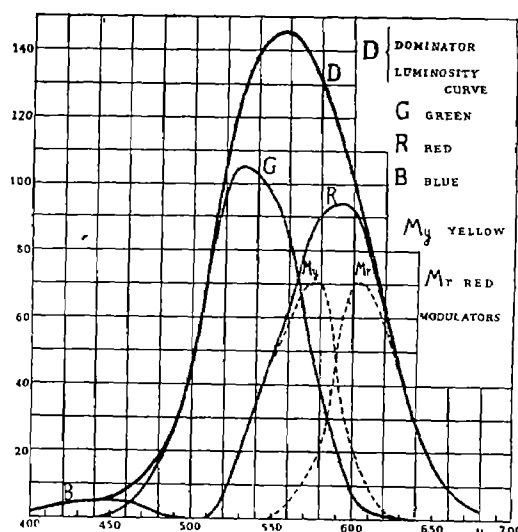


Fig 4 SYNTHESIS OF HUMAN PHOTOPIC LUMINOSITY CURVE (D), AS DETERMINED BY COBLENTZ AND EMERSON⁹ ON 125 OBSERVERS. D is the sum of three fundamental sensation curves, R, G and B, which are summed modulators as indicated for the R-curve by M_r and M_y . Spectrum of equal energy.

shown by the experiments. The broader green modulators keep the curve fairly low in the green region, though not as low as in the regions where many narrow modulators of different type overlap.

Colour blindness is easily understood as a consequence of the absence or diminished number of certain modulators, anomalies as differences in the relative number. The very essential fact that colour blindness in most cases goes with retained sensation of white follows from the experiments, which have shown that the broad dominators responsible for the photopic luminosity curve are much easier to demonstrate than modulators. In most diseases leading to colour blindness of the acquired type, white is likewise seen despite absence of sensations of colour. This suggests that the isolated modulators, responsible for colour vision, are far more sensitive to disturbing agents than the aggregates assumed to make up the dominators. Since dominators are easier to obtain and hence probably commoner than the modulators, it seems natural that a slight reduction of the number of isolated modulators will suffice to cause colour blindness, but that for white-blindness nearly all structures must be affected.

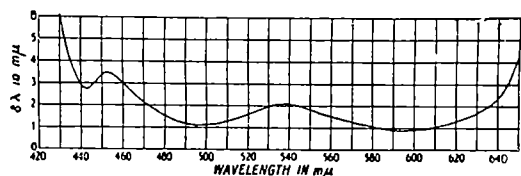


Fig 5 HUMAN COLOUR DISCRIMINATION ACCORDING TO WRIGHT AND PITT*

There are also minor differences in the location of the photopic luminosity curves between protanopic and deuteranopic colour blindness. These are best explained as differences in the proportions of the modulators making up their aggregate dominators.

Since the modulators, which are the *physiological units of colour reception*, represent a finer mechanism of colour reception than the one envisaged by the chromatic theory, it is perhaps for this reason that colour matches with three primaries never are perfect in saturation. Nature uses a greater number of primaries, at least six or seven modulators, and, possibly, a still greater number of narrow sensitivity bands within the three preferential regions of the spectrum.

A full account of this work will be published in *Neurophysiol.*, vol 8, 1945.

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THE FUTURE OF X-RAY ANALYSIS*

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[HAVE been out of contact with X-ray analysis for the last six years, this is both an advantage and a disadvantage. Because I know little of its present state, I shall not fail to see the wood for the trees, I can follow the trends, but I am certain to be wrong in detail.

The predictable future is the rational projection of the past and the present, so I shall begin by tracing the major stages of X-ray analysis in the last thirty-five years. The first stage, the Bragg period, as it may well be called, was that in which all the basic structures were worked out. The first edition of "X-Rays and Crystal Structure" contained a specimen of every basic type. It could not have been realized at the time, but every structure since has been an elaboration of one or other of these types. The same true of methods, all were then known in embryo. The next period was one of rapid development, the locates were elucidated, then the alloy structures, and a beginning was made in organic compounds with long-chain compounds, aromatics and fibre structures. The number of papers on crystal structure rose rapidly until 1933, then fluctuated about a mean. This date may be taken as the end of the heroic age

of X-ray analysis. It was then realized that the new structures would be essentially like the old ones, and interest was directed towards new and more complex phenomena. From then until the outbreak of war, activity centred round such matters as order-disorder transformations, isomorphous replacement, equilibrium diagrams and biological molecules. During the War there has been an almost complete cessation of academic crystallography, but X-ray analysis has given valuable assistance to other branches of science and industry.

What will happen when it is possible to resume a rational programme of research after the War? The only guarantee of the progress of applied science lies in keeping a proper balance between it and pure science. I believe that 'pure' X-ray analysis will find new fields more and more complex structures, and show a great development of analytic methods, while 'applied' X-ray analysis will become as essential a tool for other fields of research as the microscope and the spectroscope have been in the past.

Substances to be Investigated

In inorganic chemistry not even the simpler fields have been completely covered, but enough has been done to consider the rest as 'mopping-up' operations. There are still, however, a few groups of compounds not well understood. The first is that of the compounds of boron and carbon with other light elements. These have homopolar bonding, are very hard, and have high melting points. They may contain interstitial metal atoms, and their electrical properties are interesting. Diamond is the only one that has been worked out properly. Another group that will claim attention is the sulphides and the sulpho-salts—compounds of sulphur, arsenic and antimony with metals. They are of major interest to the geochemist, and may throw light on the genesis of metallic ores. There is also work to be done on the oxy-acids, and on the types of Wernerian complexes, the variety of which verges on the organic.

In the field of organic chemistry, there is no future in attempting to find the structures of all crystalline compounds. The basic elucidations of some types—aromatics and sterols—have given keys to organic structure determination, and interest will centre on the nature of the bonds between atoms in the molecules and those between neighbouring molecules. Chemists outnumber crystallographers by about fifty to one, so that crystallographers must make the best use of their time, they must tackle things with soluble structures, but things the chemical nature of which is unknown. One of the triumphs of crystallography during this War has been the complete determination of the structure of one extremely important compound before the chemists had unravelled its structural formula. Many substances of great chemical difficulty will be tackled in the same way.

Beyond the ordinary compounds of organic chemistry there lies the wide range of complicated biological molecules of which the proteins are the best known but by no means the only type. Intense work will undoubtedly continue both on the crystalline and fibrous states of these compounds. The structure of the proteins, fundamental to the understanding of living processes, will not yield to X-ray analysis alone, the attack must be combined with biochemical, centrifugal, electrophoretic, electron microscope and other methods, but there is no doubt that X-rays will play a crucial part in verifying all

* Substance of an evening lecture to the 1945 Conference of the X-Ray Analysis Group of the Institute of Physics, delivered at the Royal Institution on April 12.

hypothetical structures put forward on any other basis

Physics

In the field of X-ray physics, interest will be concentrated on the secondary phenomena of diffraction thermal spots, side-bands, Preston streaks, the effect of temperature on the 'micellar' structure of real crystals. There will be the development of such things as Guinier's central-spot methods, photography at high and low temperatures, high-intensity sources. X-ray tubes in current use are still at the Röntgen level, and a revolution in camera- and tube-design may be expected very soon. Goldstaub and Guinier have already shown how the electron beam can be controlled as in an electron microscope and focused to a tiny spot, so that a current of 0.1 mA will do as much as 50 mA now. There is a trend toward the use of smaller cameras, and with better tubes time-exposures will become snapshots. Filters are anachronisms, and crystal-reflected, monochromatized radiation will be the rule.

There must be great development of analytic methods and means of calculation. We are only at the beginning of the development of mechanical and optical methods, and their improvement is very necessary as calculations are becoming a bottle-neck. There is no use in being able to take photographs in a few seconds if the calculations take months.

Applications

So far, I have spoken only of straight structural analysis. There is another side to the story—the applications of X-ray analysis to other problems. This will form a larger and larger part of X-ray work. The difficulty has been that the X-ray tube and camera were considered a mysterious and dangerous instrument. People have had three hundred years to get used to the optical microscope, but only thirty to get used to X-rays. The result is that X-rays are not utilized to anything like the extent that they should be. Only the crust has been broken in their industrial application.

I see two fields of organized effort. First there will be highly concentrated specialist X-ray laboratories in universities and big firms. There will be comparatively few of these, not more than one per university or institute. Secondly, there will be standardized equipment available in every laboratory that can usefully employ it. X-ray tubes will be as universal as spectroscopes, and powder cameras as microscopes. The field of X-ray analysis ranges from well-established techniques, as in the metal industry, to the almost unexplored problem of humus formation.

In the metal industry many standard techniques are in use, such as those for the identification of materials, measurement of strain, measurement of grain size. There is considerable use of X-rays in the refractory, ceramic and glass industries—as a rough generalization one might say that the closer an industry is to metallurgy, the more satisfactory is the situation. In cement manufacture, X-rays are used chiefly for quality control, and the industry would benefit greatly from an extension of their use to the examination of raw materials and of the setting process of cement. In the chemical industry a start has been made, but it is only a start, even in the heavy chemical field. Light chemicals have scarcely been touched, and the food industry offers a great opportunity. It is true that the substances to be

investigated are 'messy', and do not give good photographs, but there is no reason to suppose that the mathematics of their interpretation cannot be worked out.

In agriculture a small beginning has been made in the identification of soil minerals, but the whole question of soil profiles and the formation of humus remains to be examined. Nagelschmidt's and Mathieu's work in this field marks the beginning of the physical understanding of soils, and its development will lead to the replacement of the present 'mysticism' by knowledge. In geology geophysics and geochemistry X-ray analysis will have a great part to play. Goldschmidt's study of mineral strata and similar problems will lead to a rational development of geophysics. Though it sounds a contradiction in terms, what is needed is an Institute of Experimental Geology, where geological processes can be reproduced and studied in detail.

The Task of Crystallographers

It would be futile to consider these prospects without discussing the means for their realization. We have a great task before us if our opportunities are not to be missed. First, we must ensure that there are enough trained people. I hope that, after the War, X-ray analysis will have a larger part in university curricula. A little of it is taught somewhere, usually in chemical or geological departments in most universities, but the only full-scale course is at Cambridge. It is up to the universities to provide greater facilities for both graduate and undergraduate instruction. The Cambridge summer schools in industrial crystallography have made a good start and should be a regular, but probably not a permanent, feature. When crystallography has found its proper place in the normal curriculum, such schools will be needed for whatever is the new subject at that time.

Secondly, there is need for improvement and standardization of apparatus. We know how difficult it is to get apparatus made to our own specifications, since the numbers required are not large enough to make commercial production profitable. We must hope that standardization will remedy this, and that it will no longer be necessary to put up with home-made apparatus. We must first, however, develop reasonable and practicable designs for all necessary apparatus. Our laboratory workshops will still be necessary, but they will be free to work on new equipment instead of spending most of their time making copies of old apparatus. An interesting thing I have noticed is the slowness of the diffusion of material techniques from one laboratory to another, even in the same country. When refitting after the War, we must make the best use of ideas that have been developed in countries other than our own. It is interesting to find that the X-Ray Analysis Group of the Institute of Physics is working on a new method of agreed specifications.

Thirdly, there is the question of publication. Before the War, crystallographic papers appeared in fifty-seven different journals, and of these only the *Zeitschrift für Kristallographie* was devoted wholly to crystallographic work. We must work for some sort of centralization. One big task is the tidying up of existing knowledge. No one has time to read everything published. A good deal of early work may be wrong, and in any event the detailed measurements

are inexact. We need some sort of a permanent up-to-date loose-leaf 'Strukturbericht'—an X-ray analogue of Groth's "Chemische Krystallographie". In pre-war days Germany was the major stronghold of such systematizing activity; but it is unlikely to be so again, at any rate for some time after this War, so we must share it out. The "X-Ray Index" is a small beginning. Crystallographers in the past have been good at co-operative international activity; the "International Tables" are one outstanding example. We may confidently expect similar success in the future.

International Aspects

Soon it will be possible to resume international contacts. In Great Britain we do not realize how much X-ray analysis has been a British subject. It has struck no deep roots in other countries, but we shall all be the gainers if others work as intensely as we. I look forward to a spread of crystallographic activity all over the world, with increasing benefits to mankind.

ANOMALOUS INACTIVATION OF HEAVY METAL ANTIFOULING PAINTS*

By Dr. G. H. YOUNG and G. W. SEAGREN

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THAT ordinarily effective antifouling paints occasionally show very poor performance, or suddenly begin to foul severely after a period of satisfactory functioning, is an observation familiar to every user of marine paints. In the case of compositions carrying metallic copper, such failures have been almost universally attributed to 'galvanic coupling' with the steel hull—the implication being strong that such paints can and do act in a manner entirely analogous to a gross sheet of copper. In an effort, therefore, to establish the real truth of this matter, the phenomenon of inactivation with both metallic copper and cuprous oxide paints has been under study by us for some time. We have already shown that accidental or deliberate contact of the steel hull with either type of copper-bearing paint can lead to serious pitting at the contact point and to accelerated corrosion attack at adjacent bare areas or 'holidays'^{1,2}. An equally if not more serious result of failure to separate properly the antifouling paint from the steel hull by adequate barrier coats is a decreased effectiveness³ or even complete inactivation of the antifouling coat¹.

While certain of our experiments are still uncompleted, we have already established that contact-inactivation can happen with cuprous oxide paints as readily as with metallic copper paints¹. The antifouling efficiency of both types is rapidly lost if they are applied over bare steel; within three months of immersion they are as badly fouled as are control panels carrying no antifouling paint. As many of these formulations have demonstrated satisfactory antifouling action if applied in the conventional manner over the usual primer and anticorrosive coats, or if applied to wood, it seems established that their immediate proximity to corroding steel is



FIG. 1. CHARACTERISTIC BANDED FOULING ADJACENT TO BREAK IN PAINT FILM.

responsible for the inactivation. It is important to note that this inactivation seldom manifests itself in the first month of exposure; this fact alone throws doubt on simple 'coupling' as the causative factor, because all fouling exposures involving unpainted copper-steel couples show immediate fouling of the 'cathodically protected' copper.

The observation—first made by us in 1942 in connexion with a series of immersed painted steel panels racked on 'Micarta' strips which in turn were bolted to plain iron angles—that 'run-down' of iron corrosion products over an antifouling paint inactivates the latter has undoubtedly been made by others, although we find no reference to it in any published reports. It is our belief that many cases of anomalous inactivation may be better attributed to this effect than to 'coupling'.

Selective Fouling

The occurrence of fouling in 'bands', either horizontal or vertical, near gross breaks in antifouling paint film on test panels where corrosion is actively going on has been the subject of much speculation². Several of our test series show this phenomenon markedly.

The North Florida Test Station exposure site at Daytona Beach, Florida, is located near the mouth of an inlet; the tidal action is such that a maximum velocity 'up-stream' approximating to 4 m.p.h. when the tide is coming in is attained; this is followed by a period of relative quiescence, then the current flow reverses, reaching a 4 m.p.h. velocity 'down-stream' at low tide. Thus, tidal action is such that a semi-stratified layer of water sweeps across the face of the test panels except when excessive wind and wave action produces turbulence and counter-currents. Accordingly, corrosion products originating at bare areas or mechanical breaks in the film may be swept out and across the surface of intact paint, in a horizontal band roughly the width of the corroding spot. Photographs of several test panels demonstrating the phenomenon are presented in Fig. 1.

Similar observations have been made at Kure Beach, Wilmington, N.C., where, however, the current flow is continuous, and in one direction only; here the area 'down-stream' of a corroding spot is always rust-stained and tends to foul well in advance of the 'up-stream' area.

We have observed the phenomenon taking place in substantially a vertical line with another series of panels bolted to, but insulated from, an unpainted steel overhead member. When fouling began, it was always the area immediately adjacent to the support at the top which fouled first, the fouling band being

* Contribution from the Stoner-Mudge, Inc., Multiple Industrial Fellowship on Protective Coatings at Mellon Institute.

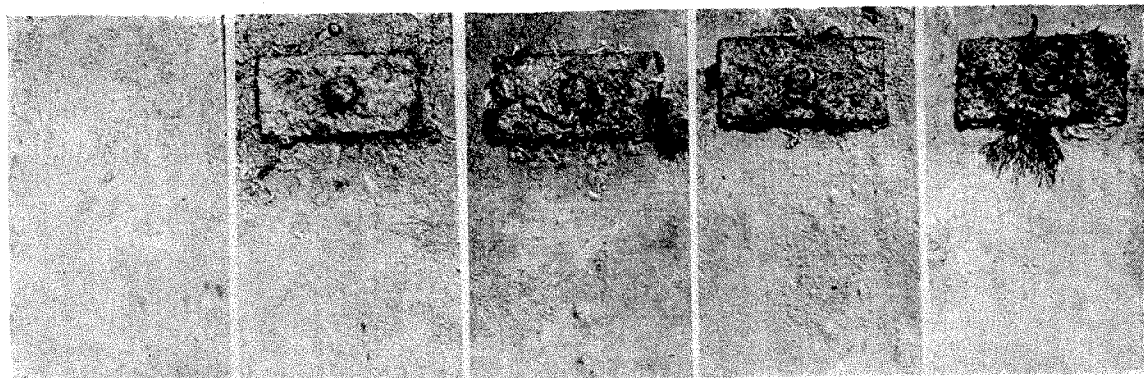


Fig. 2. BRONZE ANTI-FOULING PAINT.

as much as two or three inches wide across the top of the panel. Fouling tends to run vertically on panels exposed at mean tide-level, where the air-water interface actually moves up and down as the tide shifts. We have occasionally seen manifestations of the phenomenon on ships' hulls, where rusting and corrosion 'top-side' at a bilge port cause run-down and staining of the antifouling coat at the boot-topping zone; fouling on the stained areas usually precedes that on 'clean' paint.

Reaction with Iron Corrosion Products

There is admittedly some question as to the solubility of iron corrosion products in sea water. Wesley and Lindsley⁴ have determined the equilibrium solubilities of ferric iron in a synthetic sea water and concluded that only a fraction of a part per million could exist in solution at pH 8-8.3, normal for sea water. Despite this finding, there appears to be good evidence that iron in soluble form can and does exist in natural sea waters at concentration levels many orders of magnitude higher than predicted by Wesley's calculations. Thus, ZoBell⁵ has shown that up to 1,000 p.p.m. of ferric iron can be held in natural sea water nutrient solutions in the form of organic complexes.

Wesley himself states that, in the pH range of 7-8, 60-6,000 p.p.m. of dissolved ferrous iron is theoretically possible. This fact is important, for the *slime film*, which blankets all submerged surfaces in a matter of hours, or at most days, is characterized by a pH of only 6.3-7.6, and even lower values have been recorded. Thus ferrous iron, at least, could be concentrated in organic detritus or slime film to

values in the range of 1,000 p.p.m. This is, of course, an oxygen-deficient zone by virtue of the organic matter present; there is thus no reason to predict instantaneous and complete conversion of ferrous to ferric iron in the slime film region. ZoBell says both ferrous and ferric iron are found in natural sea water, and makes the important observation that "iron, like aluminium compounds, precipitates from solution and thus inactivates toxic agents such as silver or copper . . .".⁵

As we see it, the stream of soluble iron complex is washed along and through the slimy interface region (faster in the direction of current flow), where it reacts with and precipitates the dissolved copper; the result is an 'inactivation' of the antifouling paint. With highly gelatinous, permeable paint films, copper precipitation can take place in the body of the film itself⁶, and even at the steel-paint interface in the absence of a barrier film.

Effect of Accidental Contact with Corroding Steel

We have also attempted to determine the possible effect of accidental contact of steel bolts, anchor chain or the like against an antifouling coat on a wood hull. For this purpose we employed seasoned panels, 8 in. $\times$ 12 in. $\times$ $\frac{5}{8}$ in., coated with three coats of the two selected test paints. To these panels were attached cleaned and weighed medium carbon steel tablets, 2 in. $\times$ 4 in. $\times$ $\frac{1}{8}$ in. drilled with a $\frac{7}{8}$ in. hole at the centre, in the following several manners:

(1) directly in contact with the paint face, attached with steel bolts and nuts;

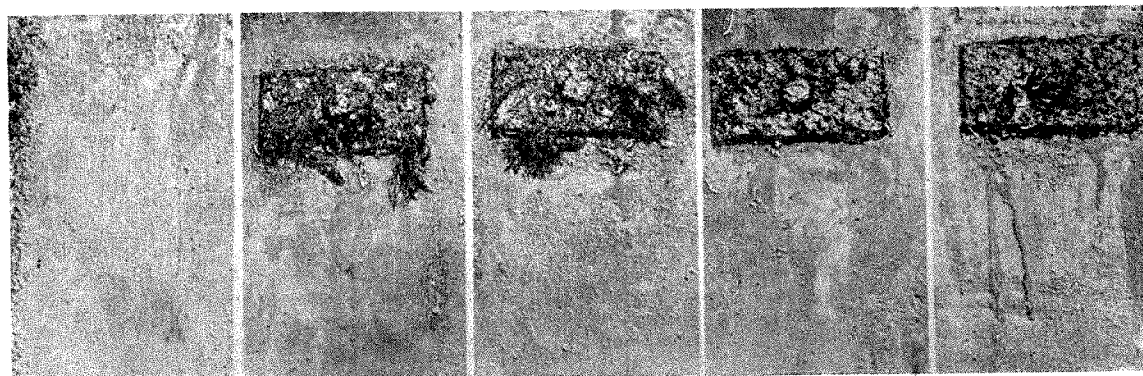


Fig. 3. CUPROUS OXIDE PAINT.

RESULTS OF FOUR-MONTH IMMERSION OF PAINTED WOOD PANELS WITH ATTACHED STEEL TABLETS

Panel No.	Paint system	Tablets attached	Fouling observations	Wt loss (gm) of duplicate steel tablets
1	Metallic copper paint	None	No fouling	
2		Method 1	Fouled over an area about 2 in around the tablets	9.3-10.0
3		Method 2	Slight fouling immediately adjacent to tablet	6.6-6.7
4		Method 3	Same as panel 3	4.9-5.0
5	Navy Formula 16	Method 4	Same as panel 3	4.6-4.5
6		None	No fouling	
7		Method 1	Fouled over an area about $\frac{1}{2}$ in around the tablets	5.1-4.9
8		Method 2	Same as panel 3	6.1-6.1
9		Method 3	Very slight fouling not associated with tablets	6.0-6.1
10		Method 4	Same as panel 9	6.8-5.3

(2) separated from the paint face by 2 in $\times$ 4 in $\times$ $\frac{1}{8}$ in 'Formica' spacers, both attached with steel bolts and nuts,

(3) separated as in (2), with 2 in. $\times$ 4 in $\times$ $\frac{1}{8}$ in Vinylite⁷ spacers, both attached with steel bolts and nuts,

(4) separated as in (2) with 2 in $\times$ 4 in $\times$ $\frac{1}{8}$ in. Formica⁷ spacers, both attached with bolts machined from cellulose acetate rods and steel nuts (This arrangement positively guarantees that no accidental contact of paint to steel can take place)

As test paints we employed a formula containing approximately 4.8 lb per gallon of metallic copper, with which we have had considerable experience^{1,2}, and Navy Formula No 16, which is based on cuprous oxide as the toxic agent⁷. Several panels carrying no attached steel tablets were included as controls

The panels were immersed at Daytona Beach, Florida, during the period March 10-July 10, 1944, after which they were removed, photographed, and returned for dis-assembly and study. Their appearance after the four months' exposure is shown in Figs 2 and 3. Weight loss data on the tablets are summarized in the accompanying table (above)

Conclusions

The following observations appear to us to be significant

(1) Only in the case of non-insulated contact direct to the face of the metallic copper formula was there an appreciable inactivation for finite distances from the bare steel, this distance was of the order of 2 in nly.

(2) The general antifouling characteristics of the remaining panels were roughly the same, and probably not significantly different from the controls. As the steel tablets were $\frac{1}{8}$ in removed from the paint-water interface, it would appear that diffusion of iron corrosion products into the interface zone, from even such short distance outside it, was insignificant

(3) The weight loss of the tablets attached directly to the metallic copper paint was significantly greater than for the remainder. This fact almost certainly indicates that here a contact-couple effect was operative,¹ the phenomenon has been discussed elsewhere²

(4) The average loss of weight of all the remaining tablets was approximately 5-6 gm, and the figures were in excellent agreement. This finding gives a calculated rate of corrosion of 100 mgm per sq dem per day. Previous studies³ on the corrosion-rate of medium carbon steel in sea water at Kure Beach, C, where no antifouling paints were in the immediate neighbourhood, gave a value of 22 mgm per sq dem per day. It thus appears that all our tablets corroded at a rate about five times the normal rate. The conclusion seems obvious that copper, migrat-

ing out of the interface region, was deposited on the steel, from which severe local-couple acceleration resulted. It is important that this phenomenon took place without any direct contact to the paint films. It is completely predictable on the hypothesis of mutual interaction of soluble iron and copper, which we advanced earlier

As a practical matter, it would thus appear that accidental contact of chain, rudder posts and similar ironware with the antifouling paint on a wood hull would have very little deteriorating effect on antifouling efficiency unless the contact area be large. Certainly, the likelihood of overall inactivation is extremely remote

¹ Young, G. H., and co-workers, *Ind Eng Chem*, 36, 341 (1944)

² Young, G. H., and co-workers, *Ind Eng Chem* (in the press)

³ LaQue, F. L., private communications based on unpublished observations

⁴ Wesley, W. A., *et al*, *Metals and Alloys*, 8, No 12, 335 (1937)

⁵ ZoBell, C. E., *J Marine Research*, 4, 42 (1941)

⁶ Moor, W. A., *Science*, 100, 494 (1944)

⁷ U.S. Navy Department, "Instructions for Painting and Cementing Vessels", 1939 Ed., Appendix 6

NATIONAL FLOUR (80 PER CENT EXTRACTION) AND BREAD IN BRITAIN

Seventh Report from the Scientific Adviser's Division, Ministry of Food

THE extraction of national flour was reduced from 82½ per cent to 80 per cent on January 1, 1945. A survey of this 80 per cent flour has been carried out on similar lines to that of the 82½ per cent national flour survey¹. Samples received from controlled mills were examined weekly for colour index and granularity and at frequent intervals for vitamin B₁, fibre, ash, calcium, iron, riboflavin and nicotinic acid, as described in the sixth report¹, with the exception that fibre was determined only on samples sent by Ministry of Food inspectors and calcium was determined only once in four weeks. In addition, about forty loaves were baked each week from different flour samples

By February 12, the quality of the new flour was approaching something like constancy (although it can still be improved considerably) and the present report describes the results obtained in the period of twelve weeks from this date to May 5. During this time, 2,943 samples of flour were examined

Composition of the Grist

The average composition of the grist used for milling the flour, calculated fortnightly during the period from data supplied by the millers and accompanying every sample, was as follows (Table 1).

TABLE 1

Fortnight beginning	Average composition of grist (capacity basis) of samples analysed			
	Manitoba wheat, %	Home grown wheat, %	Other wheat, %	Barley and rye, %
Feb 5	58.6	35.8	5.4	0.2
" 19	59.6	36.2	4.1	0.1
March 5	59.9	36.5	3.5	0.1
" 19	60.7	36.5	2.8	0.0
April 2	61.2	35.7	3.1	0.0
" 16	60.2	35.0	4.8	0.0

The 'other' wheat was principally Plate. The proportion of Manitoba is now about 3 per cent higher than in the average grist used for milling the 82½ per cent national flour (September–December 1944). This change is reflected in the average protein content of national flour, which was 11.6 per cent in 82½ per cent flour and has risen slightly in 80 per cent flour, being 11.76 per cent at the beginning of the survey, and 11.91 per cent in the fortnight beginning April 2, 1945.

Effect of Addition of Imported White Flour and of *Creta Praeparata*

The flour as supplied to the baker contained approximately 12½ per cent of imported white flour during the first four weeks of the present survey and 15 per cent thereafter. The addition consisted, on the average, of 13 per cent of Canadian and Plate flour, plus 1.8 per cent of United States flour. Owing to the high iron content of the latter, and the low fibre content of the white flours, the effect of the addition was not wholly negligible, in the tables of results which follow, the data presented relate to the flour as supplied to the public, the effect of the additions on the flour as milled is explained in footnotes. The addition of 7 oz. of *creta praeparata* per 280 lb. sack of flour increases the ash content of the flour by about 0.12 per cent.

Colour Index

Bran speck contamination was judged on the same scale as that used and described for the 82½ per cent survey (namely, 0 represents a white flour free from visible bran specks, and 100 represents a national average 85 per cent flour—capacity basis—as manufactured during July–September 1944). The percentage of all samples examined week by week that fell within the various colour index classes is shown

in Table 2 for the first three weeks and for three recent weeks, together with the average colour index values, calculated on sample and capacity bases. (The term 'capacity basis' is used frequently throughout this report. It means that the particular characteristic—colour index, fibre, B₁, etc.—is weighted for the output of flour from each mill. In calculating 'national average' figures it may be misleading to give equal weight to the result from a small mill and that from a large mill.)

TABLE 2

Colour index not exceeding	Weeks commencing					
	Feb 12	Feb 19	Feb 26	Mar 26	April 2	April 9
5	17	19	15	15	20	17
10	36	40	40	31	48	50
15	55	56	60	57	68	68
20	68	69	68	68	75	76
30	83	83	83	82	86	83
40	93	94	91	89	92	92
50	98	97	97	96	97	98
70	99	98	100	99	98	99
100	100	100	100	100	100	99
Average Colour Index						
Sample basis	19.9	19.8	19.8	21.2	18.5	18.5
Capacity basis	13.3	12.5	12.6	13.7	11.7	11.4
Number of samples	244	254	253	254	193	237

Thus the average colour index (capacity basis) has decreased from 37, the figure recorded during the last week of the 82½ per cent survey, to 11, that is, the amount of bran speck contamination is only about one third of what it was in 82½ per cent flour, or one tenth of that in the average 85 per cent flour.

Granularity

Every sample of flour received during the survey was sifted over a No. 10 standard bolting silk (aperture = 0.135 mm) under standardized conditions, using a mechanical sifter, and the percentage weight and the character of the fraction failing to pass through the silk (overtails) were recorded. Samples were encountered with up to 34 per cent tailing the silk, whereas others passed through entirely. The arithmetic mean of the percentage weight of overtails of 10 silk from 936 samples received during four consecutive weeks was 7.3 per cent, while the most frequent value was 5.5 per cent.

TABLE 3 FIBRE AND ASH IN 80 PER CENT FLOUR

	Week commencing										
	Feb 12	Feb 19	Feb 26	March 5	March 12	March 19	April 2	April 9	April 16	April 23	Av. 10 weeks
(a) Determined on individual samples											
Average fibre, %	0.20	0.23	0.18	0.19	0.20	0.22	0.20	0.24	0.21	0.21	0.21
" ash, %	0.76	0.79	0.74	0.75	0.72	0.76	0.79	0.77	0.75	0.79	0.76
" <i>creta</i> addition, oz./sk	5.7	5.4	5.1	5.1	5.4	4.9	5.0	5.2	4.4	6.5	5.3
Number of samples	13	13	14	15	11	15	10	10	12	16	
(b) Determined from composite samples (fortnightly)											
Fibre, %											
Sample basis	0.18		0.23		0.22		0.20		0.23		0.21
Capacity basis	0.18		0.21		0.19		0.17		0.21		0.19

(1) The fibre content of the flour as milled is approximately 0.016% higher than that given in the table on account of the presence of 12½–15% of imported white flour in the flour analysed.

(2) The figure for ash contains approximately 0.09% due to added *creta*. The statutory addition of *creta praeparata* is 7 oz. per 280 lb. sack of flour, the average value for samples from 231 mills analysed during the last six weeks of the present survey was 6.0 oz./sk.

TABLE 4

	Weeks commencing											
	Feb 12	Feb 19	Feb 26	March 5	March 12	March 19	March 26	April 2	April 9	April 16	April 23	April 30
Av B ₁ , IU/gm	0 77	0 77	0 78	0 80	0 78	0 80	0 80	0 77	0 82	0 81	0 77	0 79
Sample basis	0 77	0 78	0 80	0 81	0 79	0 81	0 81	0 77	0 81	0 82	0 79	0 80
Capacity basis	127	131	136	143	125	135	140	108	87	125	133	133

Note. The figures for average vitamin B₁ content above include approximately 0 01 IU/gm derived from added United States white flour

Fibre and Ash

Fibre and ash were determined on all samples sent by inspectors (about twelve samples per week). In addition, fibre was determined fortnightly on composite samples representing approximately 250 mills from these determinations, averages, on sample and capacity bases, could be calculated (Table 3)

Vitamin B₁

The weekly average values, on sample and capacity bases, of vitamin B₁ in the samples as received are given in Table 4

Riboflavin, Nicotinic Acid and Iron

The fortnightly average values for these constituents, on mill and capacity bases, are shown in Table 5

TABLE 5

	Fortnight commencing					Average for 10 weeks
	Feb 19	Mar 5	Mar 19	April 2	April 16	
Riboflavin, p p m sample and cap bases	0 8	—	0 8	0 75	0 8	0 8
Nicotinic acid, p p m, sample and cap bases	17	16	16	17	16	16 5
Iron, p p m Sample basis	15 8	16 5	16 4	16 5	15 8	16 2
Cap basis	15 8	16 8	16 5	16 7	15 6	16 3

Note. Added United States flour contains approximately 29 parts iron per million, while Canadian and Plate flour contain approximately 10 5 p p m, the iron content of the national flour, as milled before addition of imported flour is therefore approximately 0 6 p p m higher than the values given in the table. Any correction for nicotinic acid and riboflavin is well within the experimental error of the determination

Colour Index of Flour and Fibre Content

Since colour index is an estimate of the amount of bran in the flour, it should be closely related to the fibre content. Fibre determinations on 209 samples of 80 per cent national flour confirm this relationship (Table 6)

For flours with a fibre content of about 0 25 per cent or less, the colour index is probably a better estimate of the amount of bran in the flour than is the fibre determination

Colour Index of Flour and Vitamin B₁ Content

The relation between colour index and vitamin B₁ content was tabulated above for the most recent vitamin B₁ determination on samples from 283 mills

TABLE 6

Colour index	Average fibre content %	Average vitamin B ₁ content IU/gm
5	0 17 (26)*	0 80 (27)*
10	0 20 (35)	0 78 (68)
15	0 21 (28)	0 81 (60)
20	0 21 (23)	0 78 (37)
25	0 21 (21)	0 75 (19)
30	0 22 (12)	0 75 (20)
35	0 23 (11)	0 78 (9)
40	0 25 (11)	0 79 (15)
45	0 26 (12)	0 83 (1)
50	0 25 (11)	0 80 (17)
60	0 29 (6)	0 73 (8)
70	0 33 (4)	0 79 (1)
80	0 36 (2)	—
90	0 37 (3)	—
100	0 39 (4)	0 92 (3)

* The number of determinations is shown in parentheses

A similar conclusion to that drawn in the sixth report¹ is evident, namely, that there is little relation between colour index and vitamin B₁ for such a wide range of samples, that is, it is possible to combine good colour and a high B₁ value

Comparison of 80 per cent Flour with 82½ per cent and 85 per cent Flour

Average values for 80 per cent extraction flour are below set against values for 82½ per cent and 85 per cent extraction flours as given in the sixth¹ and fifth² reports respectively

TABLE 7

	80%	82½%	85%
Period covered	12 2 45 to 5 5 45	16 10 44 to 2 12 44	1 1 44 to 30 6 44
Vitamin B ₁ , IU/gm			
Sample basis	0 79	0 88	0 975
Capacity basis	0 80		
Riboflavin, p p m	0 8	1 0	1 3
Nicotinic acid, p p m	16 5	18	17
Iron, p p m			
Sample basis	16 2	19 4	20 7
Capacity basis	16 3		
Protein, %	11 8	11 6	10 7
Fibre, %			
Sample basis	0 21	0 31	0 50
Capacity basis	0 19	0 27	
Ash, %	0 76	0 88	0 98
Colour Index			
Sample basis	20	51	
Capacity basis	13	41	100
Granularity, av % wt over No 10 silk	7 3	9 8	15 5

Note. The above figures relate to national flour as received. The value for ash in the flour as milled (that is, before the addition of creta preparata and imported flour) is slightly lower, those of iron and fibre are slightly higher, as indicated in the relevant tables

Quality of Bread

Loaves baked from national flour survey samples During the period under consideration, 388 samples of flour were baked under ideal conditions in the laboratory and the resulting loaves judged for volume,

colour and quality of crumb, and were classified as follows

Quality of bread	Number of loaves	Per cent of total
Good	300	77.4
Fair-good	55	14.2
Fair	22	5.7
Poor	11	2.8

Survey of commercially baked bread During the same period, 775 samples of bread purchased from bakers in different parts of Great Britain have been examined and judged for quality (commercial standards) with the following results

Quality of bread	Number of loaves	Per cent of total
Good	87	11.2
Fair-good	366	49.8
Fair	218	28.1
Poor	84	10.9

Although there is a marked difference between the average quality of bread sold and the bread that could be made from the flour available, the great difficulties of the baking industry—particularly that of labour—must not be overlooked

This work was carried out at the Cereals Research Station, Ministry of Food, St Albans

¹ *Nature*, 154, 788 (1944)

² *Nature*, 154, 582 (1944)

OBITUARY

Dr. K. J. W. Craik

KENNETH CRAIK was born on March 29, 1914. He died as the result of an accident on V.E.-Day, May 8, 1945. Into this brief period he managed to pack achievements and promise far beyond the range of most people whose span of life is normal. His school was Edinburgh Academy. He was almost wholly on the Classical side. At seventeen he entered the University of Edinburgh. Here he read philosophy with distinction, was given his first taste of psychology by Prof. James Drever, and won the Hamilton and then the Shaw Fellowships. By now he had developed many hobbies, collecting all kinds of natural objects, constructing models, learning the accurate and minute use of tools, and developing a wide, lively and rather unconventional interest in the methods of natural science and the results of their application.

In the autumn of 1936 Craik joined the Cambridge Psychological Laboratory as a research student. It was his chief desire to undertake investigations which would bring together physical, physiological and psychological interests and methods in intimate relation. Naturally he turned to the study of the special senses. He chose 'visual adaptation' as his general problem, and devised and carried out many new experiments dealing with bright- and dark-adaptation, with those conditions at and above the threshold under which the human eye is most keenly discriminative, and with some of the phenomena of visual after-images. In 1940 he received the Ph.D. degree, and a year later, when he had considerably enlarged his dissertation, and added, in particular, a section describing a number of new and exceedingly ingenious scientific instruments for the investigation and measurement of a variety of sensory and motor functions, he was elected to a fellowship at St John's College. Under war-time arrangements, the fellowship was suspended, and Craik, still keeping his Cambridge

headquarters, embarked upon four and a half years of strenuous and devoted national service. In 1941 the Medical Research Council, for which he had carried out many of his most remarkable investigations, decided, with the concurrence of the University, to establish at Cambridge a Unit for Research in Applied Psychology. Its home was the Cambridge Psychological Laboratory, and Craik was made its first director.

No mere list of dates and honours can convey any adequate impression of Craik's vivid and vital personality, or of his promise and power. He would meet people of every rank and station in life, and of the most diverse interests and skill, and in a few minutes produce an unforgettable impression of unassuming but complete mastery. To him and to his work all three of the Fighting Services and several of the departments of civil defence owed far more than can yet be told. As his reputation rapidly grew and as more and more problems accumulated which required for their solution a knowledge of human responses to the signals and controls of the instruments of war, it became almost a matter of course in scientific and research units scattered all over the country, to say "Ask Craik, he'll know." He generally did. If he did not, he would set to work to find out. Wherever he was required he went with tireless spirit, and an indomitable good temper. He took the greatest risks, at sea, on land and in the air and enjoyed them all.

One remarkable character stamped almost all Craik's work. He would take perfectly specific questions, such, for example, as the most effective design of a particular radar display, and find in the answer some fruitful suggestions for fundamental scientific advance. At first, as a natural development of his earlier work, he was chiefly concerned with visual problems, particularly with vision at night or in conditions of bad visibility, with the design and placing of special lighting systems, and with how to arrange visual displays on many types of mechanical and electrical instruments so as to promote ready and accurate interpretation. In war and in peace, in the laboratory or in the world outside, visual signals and displays are generally used to guide operational control, and perhaps most frequently of all to set up voluntary movements in a human operator. Inevitably, therefore, Craik became more and more interested in the mechanics of bodily activity and the fundamental characteristics of voluntary movement. When the details of his work in this direction become publicly available, it will be found that they open up a vast, and largely a new, field of research.

Craik's contacts were wide and his friends many. But only those who knew him well at work, and at play, can fully appreciate the fineness of his mind and the complete honesty of his character. In experiment he was silent, absorbed, concentrated. In the workshop he showed amazing speed, unfailing resource and beautiful craftsmanship. Through many a long night of fire-watching he planned and constructed the instruments which he and others with him used to great effect. When the work was done, he flung himself into any game or discussion or party that offered, or rushed off on a journey or a visit with equal enthusiasm.

Craik's work will continue. There is no doubt about that. The Unit which he led is on the move. Whatever of good in scientific achievement it accomplishes will be the tribute which he himself would most have desired.

F. C. BARTLETT

NEWS and VIEWS

British Representatives at Soviet Academy Celebrations

AT the invitation of the Academy of Sciences of the U.S.S.R., transmitted through the Ambassador of the Union of Soviet Socialist Republics to the Court of St James, a party of scientific men and scholars left England for the U.S.S.R. on June 14 to participate in the celebration of the two hundred and twentieth anniversary of the founding of the Academy of Sciences of the U.S.S.R. The foundation of this Academy was in some measure due to the visit which Peter the Great paid to England in 1698, when he met men like Evelyn and Halley, who were then prominent members of the Royal Society of London. The following are taking part: Prof. N. K. Adam, Prof. E. N. da C. Andrade (representing the Physical Society, also the University of London), Prof. E. D. Adrian (also representing the University of Cambridge), Prof. J. D. Bernal, Prof. P. M. S. Blackett, Prof. Max Born, Prof. V. Gordon Childe (also representing the Royal Society of Edinburgh); Dr. E. M. Crowther, Sir Charles Darwin (also representing the Institution of Naval Architects), Prof. P. A. M. Dirac, Prof. F. G. Donnan (also representing the Chemical Society), Mr. W. N. Edwards, Prof. C. N. Hinshelwood (also representing the University of Oxford), Sir Thomas Holland (representing the Geological Society), Dr. J. S. Huxley, Sir Harold Spencer Jones (Astronomer Royal); Prof. E. A. Milne, Prof. N. F. Mott, Dr. Alex. Muir, Prof. R. G. W. Norrish, Dr. W. G. Ogg, Lord Radnor (representing the Rothamsted Experimental Station), Prof. E. K. Rideal, Sir Robert Robinson (representing the Royal Society of London), Prof. A. Sorsby (representing the Anglo-Soviet Medical Council), Prof. R. H. Tawney, Dr. Henry Thomas (representing the British Museum), Prof. D. M. S. Watson (also representing the British Association), Dr. W. A. Wooster (representing the Association of Scientific Workers).

James Alfred Ewing Medal

Award to Mr. B. N. Wallis

ON the joint recommendation of the presidents of the Royal Society and the Institution of Civil Engineers, the Council of the Institution of Civil Engineers has awarded the James Alfred Ewing Medal for 1944 to Mr. B. N. Wallis. The Medal is awarded annually for specially meritorious contributions to the science of engineering in the field of research. Mr. Wallis is chief of aeronautical research and development to Vickers-Armstrongs, Ltd. He invented and designed the special type of bomb used for the destruction of the Moehne and Eder Dams in Germany in 1943, and designed the Tallboy and 10-ton bombs used by the R. A. F. He was responsible for the design and construction of the airship *R. 100*. Since the airship programme was abandoned, he has been engaged in the design and development of geodetic construction to enable the production of long-range load-carrying aircraft, as exemplified in the production, in collaboration with Mr. R. K. Pierson, of the "Wellesley" type monoplane, which holds the world's non-stop record of 7,162 miles made in 1938. Geodetic construction has been used in the well-known "Wellington" bomber and the "Warwick".

Geology at Columbia University: Prof. S. J. Shand

PROF. S. J. SHAND has been appointed to fill the Newberry chair of geology at Columbia University. Shand, a graduate of the Universities of St. Andrews and Munster, spent a short time at the Royal Scottish Museum in Edinburgh, and then for twenty-five years was professor of geology at Stellenbosch. In 1937 he became professor of petrology in Columbia. He has devoted much attention to the occurrence and origin of the alkali rocks. He mapped masses of nepheline-bearing rocks in Sutherlandshire and the Bushveld, describing them in a series of masterly papers. As early as 1913 he was considering the thorny problems of the classification of eruptive rocks, and has recently elaborated one. In this the role of physical chemistry in helping to choose the diagnostic features of a rock is emphasized, and the result is practical and useful. A philosophical outlook permeates all he writes, and he has proved himself one of the most stimulating of living petrologists. Many geologists and others will be happy to learn of his promotion, and know he is a worthy successor to J. F. Kemp, C. P. Berkey and Douglas Johnson.

Industry and the University:

Exchange of Research Personnel

THE London, Midland and Scottish Railway has announced an important scheme whereby it will send members of its research staff for varying periods to carry out fundamental research in their particular fields in university laboratories, and, in exchange, the universities will be invited to send members of their staffs to spend a period in the company's research laboratory at Derby, working on applied problems in which they are interested from the fundamental side. The benefits should be felt by both parties to this arrangement. On one hand, it is hoped that the company's staff visiting the universities will be invited to assist in teaching, so bringing the practical atmosphere to the university lecture-room, on the other hand, university research men will be brought more closely into contact with the problems of industry. The L.M.S. Research Laboratory has a staff of seventy research workers, and has sections dealing with engineering, metallurgy, chemistry, physics, paint and textiles, hence it can provide a very varied experience for university research workers able to take advantage of the scheme. The company is to be congratulated on its foresight in promoting this exchange of research workers, it should prove an important step in promoting that two-way flow of research personnel between industry and the university, the need for which has been emphasized repeatedly in recent months. The example might well be followed in other industries.

Royal Asiatic Society of Bengal

IN the editorial article "Science and Progress in India" in *Nature* of May 5, p. 525, the history of the development of the present scientific background in India since the end of the eighteenth century is traced along two parallel lines of progress, official and non-official, the origin of the latter being the foundation of the Asiatic Society (now the Royal Asiatic Society of Bengal) by Sir William Jones in 1784. The annual address of Dr. Shyam Prasad Mookerjee, president of the Society for the year 1944-45, has now been received, as well as the annual report of the Council. It is pleasing that Dr. Mookerjee, the son of the late Sir Ashutosh Mookerjee,

one of the greatest presidents the Society has ever had, should have reached the presidential chair. An interesting point that emerges from Dr Mookerjee's address is that while official support was given to some aspects of science in India from as early a date as that of the birth of the Asiatic Society, the study of the cultural inheritance of India was left entirely to private non-official effort, both European and Indian, largely under the inspiration and encouragement of the Asiatic Society, until so late a date as 1860. In this year, during the time of Lord Canning, the first Viceroy of India, the Archaeological Survey of Northern India was constituted, while in 1862 Cunningham was appointed archaeological surveyor, to become later the first director-general of archaeology in India. After Cunningham came a period of stagnation until Lord Curzon reconstituted the Archaeological Department under Sir John Marshall. But the study of India's history as represented by ancient documents is still left to unofficial endeavour, organized mainly by the Asiatic Society, to which some official help is given in the form of annual grants towards the cost of study and publication.

Now that proposals are on foot for the expansion of scientific, medical and industrial research in India, the Asiatic Society, with its interests in all branches of learning—science and letters—does not propose to allow the cultural side of life to lag behind. For, as Dr Mookerjee says, "neither can India attain her full strength and glory nor can she contribute worthily to the cause of stabilizing human civilization, if we ignore the need for a proper cultural reconstruction in India." The Council of the Society, working through an advisory body formed for the purpose, has in consequence submitted to the Government of India during 1944 proposals on (1) the establishment of a Travellers' Department in India, (2) the necessity for a Central Record Office in Bengal, (3) the future development of the Archaeological Department, (4) the establishment of a National Museum at New Delhi as a war memorial, (5) the amendment of the Ancient Monuments Preservation Act, (6) the establishment of a School of Architecture in India, (7) the necessity for a National Cultural Trust, (8) the establishment of a National Academy of Art and Letters, (9) the constitution of national parks. These projects are for the future. As a useful activity for the present the Society has organized a series of discussion meetings to which invitations have been extended to all members of the Allied Forces in Calcutta. No less than thirty-nine meetings were held during 1944, addressed by a variety of lecturers on historical, literary, economic, industrial, and scientific subjects. The British and American military authorities co-operated in making these meetings a success, the one by a contribution towards the expenses, and the other by gifts of materials for providing refreshments. The Asiatic Society of Bengal proposes next year to celebrate the bi-centenary of the birth of its founder, Sir William Jones.

Astronomy in France during the Occupation

In the February issue of *The Observatory* (66, 23, 1945), D. Chalonge gives a brief history of French astronomy and astronomers during the German occupation. Among the astronomers dismissed under the Vichy racial decrees—M. Lambert, director of the Bureau International de l'Heure, M. Mendès, M. Beloritzsky and Mlle Bloch, assistants at the

Observatories of Bordeaux, Marseilles and Lyons respectively—all have been reinstated except M. Lambert, who was arrested in August 1943 and deported to Germany, and about whose safety there is anxiety. M. Meneur, director of the Institut d'Astrophysique, was several times imprisoned for political reasons. Removed by the Vichy Government from his post at the Observatory of Paris, he devoted much of his time to the resistance movement, and is now back with his former colleagues. M. Danjon, director of the Observatory of Strasbourg and dean of the Faculty of Science in the University, was also many times arrested by the Germans during the Gestapo campaign against the University, and was finally dismissed by the Vichy Government. Many astronomers were, however, allowed to work in the tranquillity of their observatories. In some cases this tranquillity covered patriotic activities, the observatories becoming meeting-places for the local resistance groups where pamphlets were printed and arms stored. Observatory buildings throughout France have come through the War unscathed, except perhaps those at Strasbourg, about which news is still lacking.

Development of the Service d'Astrophysique, founded in 1936, was interrupted by the outbreak of war. The Institut d'Astrophysique buildings in Paris were finished externally in 1940 when the Germans forbade further work, but this edict was clandestinely evaded with such success that workshops and laboratories were ready for use by January 1944. At the Observatory of Haute Provence, which forms part of the Service d'Astrophysique, many of the projected buildings were completed, and a 120-cm telescope was brought into use a year ago. An 80-cm telescope will shortly be installed in a dome already awaiting it. Work has continued on the Pic du Midi, where Lyot has carried on his researches on the solar corona outside eclipse and on planetary surface detail. Other researches published or to be published in the *Annales d'Astrophysique* include work on the night sky spectrum, photometric and spectrophotometric studies of lunar eclipses, investigations, observational and theoretical, on the continuous spectra of stars and diffuse nebulae, observations of total hydrogen absorption in certain stellar spectra, and a study of the monochromatic brightness across the sun's disk.

Public Health in San Salvador

An article on this subject appears in the February issue of the *Boletín de la Oficina Sanitaria Pan-americana* by Dr Manuel Zúñiga Idíáquez, head of the Department of Health Education of the El Salvador Ministry of Health. San Salvador's public health organization traces its origin to the Superior Board of Health at the beginning of this century, which was succeeded in 1920 by the National Department of Health. Since then much progress has been made as regards the preventive, rather than the curative, side of public health and the training of staff. The Rockefeller Foundation and the Pan-American Sanitary Bureau have been of great help, especially as regards the formation of a body of specialists in public health. At the present time valuable aid is also being received from the Co-operative Inter-American Public Health Service, permitting the installation of safe water and sewage disposal systems, malaria control work, sanitary materials, public laundries and new buildings and health centres.

Medical Research in Sweden

A COMMITTEE of Swedish experts has drawn up plans for the establishment of a Central Council for Medical Research, and the granting of yearly allocations of Kr. 1,000,000 for medical research. The committee recommends that the annual sum of Kr. 400,000 should be granted for medical research at the Universities of Uppsala and Lund, the Caroline, Dental and Veterinary Institutes, and that Kr. 600,000 should be put at the disposal of the Council. As projected, the sum of Kr. 400,000 is to be divided among the five university colleges every year. Further, the sum of Kr. 135,000 would be used for bursaries of Kr. 5,000 each for students' courses on medical and related subjects. The Council could, among other things, have the task of organizing collaboration between scientific men working on research in natural science and medicine.

Summer School in Social Biology

At the Summer School in Social Biology which the British Social Hygiene Council (Tavistock House North, Tavistock Square, London, W.C.1) will be holding at University College, Nottingham, during July 28–August 11, interest will be directed chiefly to problems of education and social life likely to arise through the coming increase in the school-leaving age. The director of the School will be Prof. Winifred Cullis. The School is open to teachers, social workers and members of the general public interested in education and social problems from a biological angle. The morning lecture programme has been planned to illustrate the aims and content of social biology. Tea-time discussions will be reserved for subjects concerned with actual classroom problems of teaching social biology. In addition, an elementary course in the dissection of certain animal types will be available for those teachers who make special application. At the evening sessions lectures will be given by a distinguished group of visiting speakers on the broader application of biological knowledge to human life and culture. Acceptances to speak have been received from Prof. T. H. Morgan, Sir Drummond Shiels, Dr. Otto May, Father Cyster King, Dr. Glover and Dr. David Mace. One special feature of the Summer School will be the Sunday sessions, at which lectures and discussions will be held upon the relation of biological science to "higher values and spiritual life". Further information about the School can be obtained from the secretary, British Social Hygiene Council, Tavistock House North, Tavistock Square, London, W.C.1.

South-Eastern Union of Scientific Societies

THE fiftieth annual congress of the South-Eastern Union of Scientific Societies will be held this year on July 7 at Harpenden, the headquarters being at the Rothamsted Experimental Station. The president-elect is Dr. W. G. Ogg, who will speak on some aspects of the work at Rothamsted, of which he is rector. The sectional presidents and their addresses are: Mr. Edward Yates (archæology), "Church Halls"; Dr. W. E. Brenchley (botany), "Trace Elements"; Mr. P. Evans (geology), "Some New Weapons in the Geological Armoury"; Dr. C. S. Elwin (social science), "Country Planning"; Dr. S. Russell (zoology), "Fishing Research and the Overfishing Problem". The honorary general secretaries of the Union are Mr. A. Farquharson and Mr. J. Epps, 78 Dunwich Road, Bexley Heath.

University of London Appointments

DR. A. B. HILL, since 1933 University reader in epidemiology and vital statistics at the London School of Hygiene and Tropical Medicine, has been appointed to the University chair of medical statistics tenable at the School, as from October 1. During 1939–42 Dr. Hill was in charge of the Statistical Section in the Research and Experimental Department of the Ministry of Home Security, and since 1934 he has served part-time on the staff of the Medical Directorate of the Royal Air Force and was appointed consultant in medical statistics to the Royal Air Force.

Dr. Karl R. Popper, since 1937 senior lecturer in philosophy at Canterbury College, New Zealand, has been appointed to the readership in logic and scientific method tenable at the London School of Economics, as from October 1.

The title of reader in organic chemistry in the University of London has been conferred, as from October 1, on Dr. E. R. H. Jones, in respect of the post held by him at the Imperial College of Science and Technology.

Television—Past and Future

IN the account in *Nature* of May 26 of an address by Mr. H. L. Kirke, the statement is made (p. 622) that a mobile transmitter was "developed by the B.B.C." for supplying outside broadcast television features. Mr. Kirke writes stating that the script of his lecture read: "the pioneer development work in the use of Post Office cables in this way was done by the B.B.C.". He adds, "the development of the mobile transmitter was undertaken by Messrs. E.M.I., although I did not actually mention this in my lecture or in the script."

Announcements

SIR PEIRSON FRANK, chief engineer of the London County Council, has been elected president of the Institution of Civil Engineers for 1945–46.

At the annual general meeting of the Institute of Physics, held on June 4, the following were elected to take office on October 1, 1945: *President*, Sir Frank Smith; *Vice-President*, Prof. A. M. Tyndall; *Honorary Treasurer*, Major C. E. S. Phillips; *Honorary Secretary*, Prof. J. A. Crowther; *Ordinary Members of the Board*, Dr. B. P. Dudding, Mr. A. J. Maddock, Prof. W. Sucksmith and Dr. C. Sykes. Prof. C. T. R. Wilson was elected an honorary fellow of the Institute.

MESSRS. NEWTON CHAMBERS AND CO., LTD., are providing the South Yorkshire Section of the Royal Institute of Chemistry with a sum of £100 per annum for five years for the award of an annual prize for contributions to the subject of chemistry and industrial welfare. The 1945 competition is open to any fellow, associate or registered student of the Institute who had not reached his thirty-sixth birthday by January 1, 1945, and the award is offered for an essay, paper or papers, published or unpublished, embodying the candidate's own observations, or experimental work, on some aspects of the application of chemistry to the promotion of industrial welfare. A critical examination of existing knowledge is admissible, provided that the conclusions reached constitute an addition to the knowledge of the subject. Papers must reach the honorary secretary of the South Yorkshire Section, Royal Institute of Chemistry, c/o Newton Chambers and Co., Ltd., Thorncliffe Works, Sheffield, by December 31, 1945.

LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications.

Dirac's Equation for the Neutron and Proton

In the attempt to discover a place for Dirac's equation in the geometry and metric of the physical world, it has been proposed to make use of Weyl's concept of gauging. It was thus proposed to bring about the union of gravitation and electromagnetism by Kaluza's suggestion of the adoption of a five-dimensional continuum leaving the idea of gauging free to bring about the union of the quantum theory with these branches of physics.

In order to carry out this idea, it was found necessary to introduce the concept of matrix-length and to apply a parallel displacement to it. A gauging factor, ψ , was introduced which was identified with the ψ of Dirac's equation. The result of the argument was the equation

$$\gamma^\mu \frac{\partial \psi}{\partial x^\mu} = 0,$$

as the condition that there should be no change in length in a parallel displacement. In this equation the matrices (γ^μ) are five in number and are readily related to the familiar Dirac matrices. The equation can be regarded as a gauging equation and is identical with Dirac's equation¹.

In the original work the equation was more general and can be expressed in the form:

$$\gamma^\mu \frac{\partial \psi}{\partial x^\mu} = H_\mu \gamma^\mu \psi.$$

This is the result of a close analogy with the idea of Weyl that a change of length occurs with a parallel displacement, and in place of the electromagnetic potential (ϕ_μ), the operator (H_μ) occurs. It appeared from the identity of the equation, which resulted from placing $H_\mu = 0$, with Dirac's equation that the purpose of incorporating Dirac's equation in a natural way into physical theory was achieved by this simple condition. But the development of the theory of the nuclear field has shown that it bears to the five-dimensional framework a relation similar to that which exists between the electromagnetic theory and gravitation². Thus it would be natural to drop the simple equation $H_\mu = 0$ when a nuclear field exists. If we can decide upon the correct expression for H_μ in this case, the result should lead to Dirac's equation for the neutron and proton.

Following Weyl, it would be expected that H_μ depended linearly upon the potential components, usually denoted by U_μ . But in the five-dimensional theory these are the components, ($T_{\mu\nu}$), of the tensor of the nuclear field in which the suffix 5 appears. Thus it is in the interest of generality to express H_μ linearly in terms of the components, $T_{\mu\nu}$.

The simplest operator form is that which results from combining the matrices (γ^μ) with ($T_{\mu\nu}$) in order to produce a covariant quantity H_μ . At the same time it is necessary to include the matrices $\tau = \begin{pmatrix} 00 \\ 10 \end{pmatrix}$

and $\tau^* = \begin{pmatrix} 01 \\ 00 \end{pmatrix}$ to account for the neutron-proton interchange. Thus the simplest form is $H_\mu =$

$g\gamma^\nu(T_{\mu\nu}\tau + T_{\mu\nu}^*\tau^*)$, where g is a constant, and where as usual in the field theory we combine $T_{\mu\nu}$ and its conjugate complex quantity. Thus the proposed quantum equation for the neutron and proton

$$\gamma^\mu \frac{\partial \psi}{\partial x^\mu} = g\gamma^\nu \gamma^\mu (T_{\mu\nu}\tau + T_{\mu\nu}^*\tau^*) \psi.$$

This equation appears in a paper by H. J. Bhabha in which he develops equations for the nuclear field by the Hamiltonian method. A characteristic feature of the form of the equation developed here is the appearance of one constant, g , only. In other presentations the field is characterized by the appearance of two constants, g_1 and g_2 . It would appear from the equation that $g_1/g_2 = 2\pi M_0 c/h$, where M_0 is the mass of the particle emitted in the neutron-proton interchange. This agrees with the five-dimensional formulation of the nuclear theory⁴.

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¹ Flint, *Proc. Roy. Soc., A*, 150, 432 (1935).

² Flint, *Phil. Mag.*, vii, 29, 330 (1940).

³ Bhabha, *Proc. Roy. Soc., A*, 166, 520 (1938).

⁴ Flint, *Phil. Mag.*, 7, 33, 369 (1942).

Coloured Haloes Surrounding Inclusions of Monazite in Quartz

QUARTZ crystals with zonal colour from the Transbaikalian region were found with inclusions of monazite crystals (diameter 0.1–1.0 mm.) around which the quartz was of an intense smoky colour. The coloration, more intense at the centre, shaded off gradually towards the periphery of the halo. Although the boundaries of the halo were not sharp, yet they were sufficiently distinct to enable measurements of the halo to be made (Fig. 1). Haloes of all dimensions from 0.5 mm. to 5–6 mm. diameter can be found in the same quartz specimen.

The formation of these spherical haloes can be attributed to the corresponding radioactive emanations (β or γ). Calculations have shown that haloes of such dimensions and with sufficiently well-marked boundaries could be produced by the action on quartz of hard β -rays (in quartz $\mu \approx 10 \text{ cm.}^{-1}$) spreading

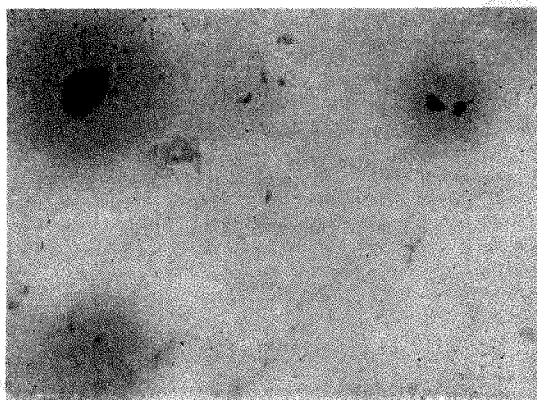


Fig. 1. $\times$ about 7.

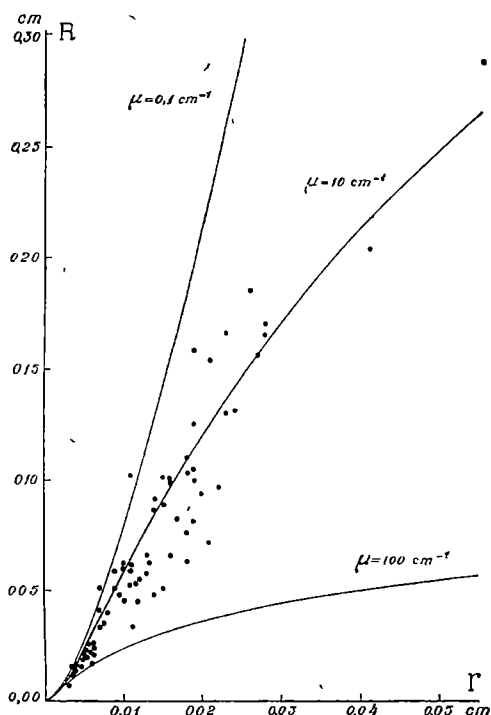


Fig 2

om the monazite and presumably emanating from sintegration products of thorium contained in onazite. These spherical haloes in quartz are the first clearly observed natural colouring action of rays, and can be called β -haloes to distinguish them from the well-known concentric α -haloes.

For haloes of the same geological age (in the same quartz specimen), the radius r of the inclusion can be related, as a first approximation, to the radius R of the halo by the equation $r = \sqrt[3]{kR^2e\mu R}$, confirmed by observation (Fig 2).

With geological ageing, owing to accumulation of the pigment, the boundaries of the halo gradually extend. After comparing the action on a given specimen of a standard preparation to determine the constant k , an attempt can be made to determine approximately, from the length of the radius of the halo, the time necessary for the production of a just perceptible coloration in the quartz, at a given distance from a source of given intensity. The formula $t \approx \tau \ln [(k^2 Q_0^{-1} R^2 e \mu R) + 1]$, where $\tau = 1/\lambda$ is coefficient of disintegration) enables such calculations to be made.

In addition to the intensity of the source of radiation and the time of action, the radius of the β -halo depends also on the power of the given medium to colour, that is, the degree of its sensitivity (due possibly to presence of Fe). Thus sometimes, far beyond the boundaries of the halo itself, in the more sensitized layers of the quartz crystal, traces of the action of the radiation can be observed as coloured streaks.

By artificial action of, say, X-rays, the whole crystal becomes coloured and layers of more intense colour appear which were not apparent before. Previously only those layers of quartz were coloured, considerably fainter than the haloes, which were formed at a time when monazite crystals were being deposited. The quartz presumably adsorbed from

solution the sensitizing as well as the active admixture. This occurred in periods of growth following periods of rest or even re-solution of the crystal due to external phenomena, indicated by the rounding of zones at the apexes and edges of the crystal below the coloured zones where inclusions of monazite with surrounding β -haloes are found.

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Chromatography of Two Solutes

THE complete theory for the chromatography of a single solute has been given recently^{1,2}, but the general case of two or more solutes has not yet been solved^{3,4}.

We consider the problem for two solutes I and II, where the amounts adsorbed are given by the respective adsorption isotherms

$$q_1 = f(c_1, c_2) \quad , \quad q_2 = g(c_1, c_2).$$

There is no need to assume a specific form for f and g , but we shall suppose, what is almost certain to be the case, that they are regular functions of c_1 and c_2 for small c_1 and c_2 .

It is well known that the following differential equations are satisfied

$$\frac{\partial c_1}{\partial x} + \frac{\partial f}{\partial v} = 0 \quad , \quad \frac{\partial c_2}{\partial x} + \frac{\partial g}{\partial v} = 0. \quad (1)$$

One can show that under normal initial conditions c_1 and c_2 are functions of v/x . However, sometimes in the subsequent development of the bands with pure solvent this may cease to be true.

Writing $y = \frac{v}{x}$, we can show that either $\frac{dc_1}{dy} =$

$\frac{dc_2}{dy} = 0$ which implies that c_1 and c_2 are constants, or

$$\frac{df}{dc_1} = \frac{dg}{dc_2} = y, \quad (2)$$

from which we deduce that

$$\frac{dc_1}{dc_2} = \frac{2f'c_2}{(g'c_2 - f'c_1)} \left\{ 1 + \sqrt{1 + \frac{4f'c_2 g'c_1}{(g'c_2 - f'c_1)^2}} \right\}^{-1}.$$

This equation determines c_1 as a function of c_2 , and then each can be obtained as a function of (v/x) from the relation

$$\frac{v}{x} = f'c_1 + \frac{2f'c_2 g'c_1}{(f'c_1 - g'c_2)} \times \left\{ 1 + \sqrt{1 + \frac{4f'c_2 g'c_1}{(g'c_2 - f'c_1)^2}} \right\}^{-1} \quad (3)$$

It has been shown already by Wilson³ and de Vault⁴ that if a chromatogram is made from a solution of two substances, the normal result is to obtain a band in which the two solutes I and II are mixed in constant proportions determined by the original concentrations, and then below this a band containing only one of the solutes with a uniform distribution determined by the original concentrations.

If the original concentrations do not differ greatly, then the lower band will usually contain the solute which is the less strongly adsorbed. However, if the concentration of one solute is small compared with the other, then the lower band may very likely contain the more concentrated even when it is the more strongly adsorbed component. For convenience of expression, we shall always suppose that the lower band consists of solute II.

When we develop the chromatogram with pure solvent, both bands move down the tube and a third band is formed at the top. This new band consists of solute I if

$$(f'c_1)c_1=0 > (g'c_2)c_2=0, \quad (4)$$

and of solute II if the inequality opposite to (4) is satisfied. The resulting chromatogram will normally consist of a band of solute I of varying concentration, a band of a mixture of solute I and II, and below this a band of solute II. However, if the original concentration of the solute I is small compared with that of II, and if the opposite inequality to (4) is satisfied, then we may have a band of II, a mixed band and then a band of solute II again and no free solute I.

Let us suppose that the inequality (4) is satisfied. The top edge of the band of solute I after development with a volume v of pure solvent will then be given by

$$\frac{v}{x} = (f'c_1)c_1=0; \quad (5)$$

and the top edge of the band consisting of a mixture of solutes I and II by the simultaneous equations

$$\frac{v}{x} = (f'c_1)c_2=0 = (g'c_2)c_2=0$$

This enables us to estimate the amount of solute I set free by development with a given volume of pure solvent and the volume of pure solvent required to separate completely the two solutes. If $F(c_1) = f(c_1, 0)$ and if c'_1 is determined by

$$F'(c'_1) = [g'c_2(c'_1, c_2)]_{c_2=0}, \quad (6)$$

then the amount of pure solute I after development with volume v will be

$$v \left\{ \frac{F(c'_1)}{F'(c'_1)} - c'_1 \right\}$$

If the original chromatogram was formed from a volume v_0 of the solutes I and II, then the volume v of pure solvent required to separate completely the solutes is given by

$$v \left\{ \frac{F(c'_1)}{F'(c'_1)} - c'_1 \right\} = v_0 c_1^0, \quad (7)$$

where c'_1 is given by (6) and c_1^0 is the original concentration of solute I.

A full account of the theory will be published elsewhere, and related experimental work is in progress.

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Feb 28

Absorption of Cosmic Rays at Colombo and London

Using the standard form of G.M. counter telescope of Fig 1, we have made a comparison of the absorption of the vertical component in lead at sea-level, in London and a Colombo, the only difference between the two sets of apparatus being that, at Colombo, the top counter was missing. The results are given in Figs 2 and 3, the deviations shown being standard deviations, and the following values are found for the percentage soft component and absorption coefficient of the hard component

	Soft component (% of total)	Mass absorption coefficient hard component
London	29 ± 0.7	$5.1 \times 10^{-4} \text{ cm}^2/\text{gm}$
Colombo	23 ± 1	$5.1 \times 10^{-4} \text{ cm}^2/\text{gm}$

A plateau was found on both curves for thicknesses greater than 10 cm (that is, after complete absorption of the soft component), the significance of this will be more fully discussed elsewhere. This is where the hard component is produced back to zero thickness as shown in the dotted lines.

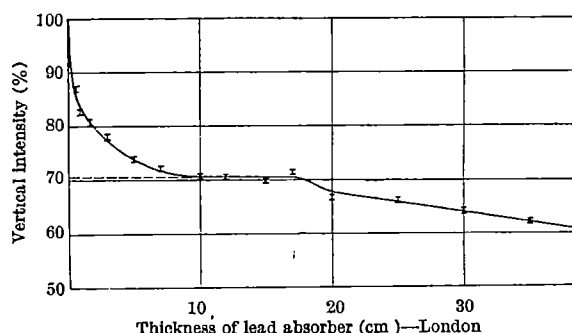


Fig 2

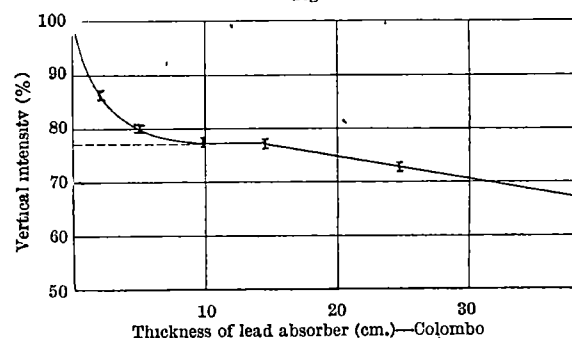


Fig 3

The absorption coefficient of the meson or hard component is found to be the same in both places and agrees with that found by other workers¹, but there is a significant drop in the percentage of the electronic or soft component at Colombo.

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¹ Weiss, J., *J. Chem. Soc.*, 297 (1943).

² de Vault, D., *J. Amer. Chem. Soc.*, 65, 532 (1943).

³ Wilson, J. N., *J. Amer. Chem. Soc.*, 62, 1583 (1940).

¹ Sittkuss, Z. *Phys.*, 108, 432 (1938).

Ultimate Vacuum Attainable by a Diffusion Pump

THE following experiments were recently performed to see the nature of pumping action inside a diffusion pump and to throw some light on the controversial question of the ultimate vacuum attainable by a diffusion pump.

While Gaede¹ and Langmuir² held that there is theoretically no limit to the vacuum produced by diffusion pump, Hickman^{3,4} reported that the limit of pumping is set at the vapour pressure of the pump fluid at room temperatures, and he devised the 'self-fractionating' oil-diffusion pump which is capable of producing higher vacuum. Newman⁵ believed that the pumping action would cease when the partial pressure of air, contained in the jet vapour as contamination, equals the pressure in the vessel.

Table 1 shows the pressure gradient down the barrel of an orthodox oil-diffusion pump with single umbrella-type jet, all brass and 4-in. in diameter. Tappings of nozzles were taken from seven different positions relative to the vapour jet, and could be connected to vacuum gauges. The pump was charged with Apiezon oil B, and had been in use for a few weeks.

A rubberless McLeod gauge was used for reading the pressure and also for calibrating a Pirani gauge. The Pirani gauge was calibrated across a liquid oxygen trap, so that without the trap the Pirani reads the total pressure (partials of air and vapour), as contrasted with a McLeod gauge which reads air pressure only. Table 2 shows the vacuum (partial and total) obtained by a three-stage mercury diffusion pump without a cold trap.

It is brought out clearly by the experiments that a diffusion pump can reduce the partial pressure of air far below the vapour pressure of the fluid, and as long as the pump is running, the vessel is not filled with the fluid vapour up to its saturation value for the room temperature. The partial pressure of air contamination of the jet will, similarly, not manifest itself fully in the vessel.

The successful functioning of a diffusion pump is apparently vitally dependent on the streamline issue of the jet vapour, and the small differences of vapour pressure of the fluid are not likely to affect the vacuum to any great extent. A perfect streamline flow of the jet vapour directed away from the diffusion aperture (neck) would cause only the fusing out of the air (or vapour, etc.) from the vessel into the jet stream, where the molecules would

TABLE 2 VACUUM PRODUCED BY A THREE-STAGE MERCURY-DIFFUSION PUMP. PRESSURE IN μ OR 10^{-3} MM. HG. (WITHOUT A TRAP)

Measured by McLeod gauge	Pirani gauge	Partial press of Hg (diff of 1 and 2)	Vapour press of Hg at room temp 26°C	Ratio of back- diffusion of mer- cury vap to sat- uration pressure = $\frac{\text{col 3}}{\text{col 4}}$
1	2	3	4	5
0.02	0.50	0.48	2.0	0.24

be caught by the forward stream of vapour and knocked on towards the backing pump, and would lead theoretically to perfect vacuum with time.

The practical vacuum, however, would depend upon the degree of back-streaming at the jet for several reasons, chiefly, the imperfection of the jet design, and the turbulence and pressure condition below the jet. The back-diffusion consists of vapour (easy to freeze out) as well as air. The latter (air) comes from the contaminated fluid from the boiler where the fluid returns through the air-laden column at the lower ('compression') part of the diffusion pump barrel. The turbulent condition set up by the abrupt rise of pressure below the single jet is also responsible for the back-escape.

The process of 'self-fractionation', originated by Hickman, not only helps in grading out the degenerated fractions of the oil but also helps very much in freeing oils of the inner compartments from air contamination. The inclusion of a number of jets in the fractionating pump also helps in getting more perfect streamline flow of vapour at the upper jets. This picture accords well with the success of a fractionating oil diffusion pump without laying too much stress on the vapour pressure of pump fluid, as demanded by the diffusion theory and the present experimental evidence.

Work is in progress and the details will be published elsewhere.

Our thanks are due to Prof M. N. Saha for his keen interest in the work. Our thanks are also due to Mr J. R. Basu Mallick, for designing the tappings and getting the oil diffusion pump constructed for the purpose. We also acknowledge our thanks to the authorities of the Board of Scientific and Industrial Research for kindly permitting the work to be published.

KAMALESH RAY

NANDA DULAL SENGUPTA

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Calcutta. March 14

TABLE 1 DISTRIBUTION OF PRESSURE IN μ (10^{-3} MM. HG.) INSIDE A SINGLE-STAGE OIL-DIFFUSION PUMP (WITHOUT A TRAP)

Position of tappings relative to vapour jet	Pressure measured by McLeod gauge (partial press of air)	Pirani gauge (total press)	Partial press of oil vap = diff of cols 2 & 3	Ratio of vap press to air press = $\frac{\text{col 4}}{\text{col 2}}$
1	2	3	4	5
7.0 in above jet	0.05	0.40	0.35	7
3.0 in above jet	0.02	0.26	0.24	12
1.5 in above jet	0.03	0.23	0.20	6.6
At the jet	4.0	6.0	2.0	0.5
1.5 in below jet	2.5	8.0	5.5	2.2
3.0 in below jet	2.0	5.0	3.0	1.5
6.5 in be- low jet (at backing)	2.0	4.0	2.0	1.0

¹ Gaede, W., *Ann. Phys.*, **46**, 357 (1915).

² Langmuir, I., *Phys. Rev.*, **8**, 48 (1916).

³ Hickman, K. C. D., *J. Frank. Inst.*, **221**, 215 (1936).

⁴ Hickman, K. C. D., *J. App. Phys.*, **11**, 303 (1940).

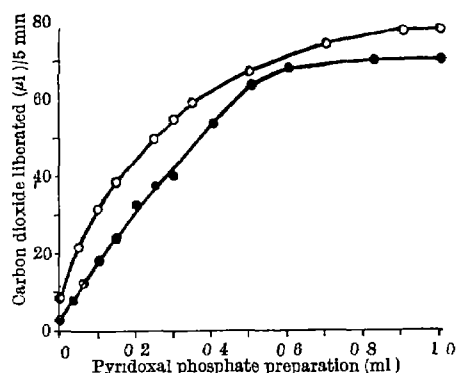
⁵ Newman, F. H., "Production and Measurement of High Vacuum",
52

Codecarboxylase Function of 'Pyridoxal Phosphate'

Six specific amino-acid decarboxylases have now been obtained in a cell-free state from various bacteria^{1,2,3,4}. Of these, the enzymes decarboxylating *l*(+)-lysine, *l*(-)-tyrosine, *l*(+)-arginine and *l*(+)-ornithine have been resolved into apoenzyme moieties activated by the presence of a common codecarboxylase of which a concentrate has been prepared from yeast⁵. The remaining enzymes,

specific for *l*(-)-histidine and for *l*(+)-glutamic acid, have not been resolved and appear not to contain codecarboxylase. The four codecarboxylase enzymes are highly sensitive to cyanide, hydrazine, hydroxylamine and semicarbazide, suggesting that a keto-group is involved in their action⁴.

Strains of *S. faecalis* which possess tyrosine decarboxylase are unable to produce the enzyme when grown in a simplified medium⁶, the active enzyme being formed only if the medium contains amounts of nicotinic acid and pyridoxin in excess of simple growth requirements⁷. Organisms grown in pyridoxin-deficient media are almost inactive towards tyrosine but can be activated by the addition of pyridoxal to the suspensions⁸; if the cells are dried, then pyridoxal is active in the presence of adenosinetriphosphate but inactive alone⁹. In the latter case an active substance can be obtained by treating pyridoxal with thionyl chloride followed by silver dihydrogen phosphate or with phosphoric acid alone⁹. Pyridoxal and pyridoxamine act as the 'pseudo-pyridoxin' growth-factor for *S. lactis* R.¹⁰



EFFECT OF 'PYRIDOXAL PHOSPHATE' CONCENTRATION ON RATE OF DECARBOXYLATION OF *l*(-)-TYROSINE BY TYROSINE APO-DECARBOXYLASE (●-●) OF *l*(+)-LYSINE BY LYSINE APO-DECARBOXYLASE (○-○)
Manometer cups contain 0.3 ml apo enzyme preparation, 0.5 ml *M*/15 tyrosine or lysine, 1.5 ml *M*/5 acetate buffer pH 5.5 (tyrosine enzyme) or *M*/5 phosphate buffer pH 6.0 (lysine enzyme), water/'pyridoxal phosphate' preparation to 1.0 ml
Temperature = 30°C

We have now tested the codecarboxylase activity of 'pyridoxal phosphate' with the apo-decarboxylases specific for lysine, tyrosine, arginine and ornithine prepared and tested under optimal conditions as previously described^{1,2,4}. We obtained pyridoxal in about 20 per cent yield by oxidation of pyridoxin with neutral potassium permanganate under conditions similar to those described by Harris, Heyl and Folkers¹¹. The 2,4-dinitrophenylsemicarbazone was prepared, mp 212° (found C, 46.1, H, 4.0, C₁₅H₁₄N₄O₇, requires C, 46.2, H, 3.6 per cent). Pyridoxal was inactive as codecarboxylase when tested against tyrosine apo-decarboxylase but was activated if incubated in the presence of the enzyme preparation and adenosinetriphosphate. Before phosphorylation, pyridoxal was purified through the oxime and acetal, and the hydrochloride of the aldehyde then refluxed for five minutes with an excess of thionyl chloride before standing overnight. Excess reagent was removed *in vacuo* and the product shaken with a suspension of silver dihydrogen phosphate in glacial acetic acid for 24 hours. Filtration followed by removal of acetic acid *in vacuo* left a resin. This was dissolved in water and silver ions

removed by addition of dilute hydrochloric acid. The preparation was preserved as the lead salt.

TABLE 1 CODECARBOXYLASE ACTION OF 'PYRIDOXAL PHOSPHATE' Activities estimated manometrically, as previously described^{1,2}

Apo-enzyme	Alone	+ excess codecarboxylase	+ excess 'pyridoxal phosphate'
<i>l</i> (-)-Tyrosine decarboxylase	2	110	116
<i>l</i> (+)-Lysine decarboxylase	15	108	104
<i>l</i> (+)-Arginine decarboxylase	15	70	75
<i>l</i> (+)-Ornithine decarboxylase	29	78	74

Table 1 shows that the preparation is active as codecarboxylase for the four enzymes, and the accompanying figure shows the shape of the curves obtained by adding increasing amounts of the preparation to a given amount of the apo-enzymes of lysine and tyrosine decarboxylases and measuring the resulting decarboxylase activities. Codecarboxylase from yeast is stable to mild alkaline hydrolysis and unstable to acid⁵, table 2 shows that the active material in the 'pyridoxal phosphate' preparation has similar stabilities. Proof of the identity of the synthetic and natural products must await their isolation in a pure state; the concentrate of natural product was stated formerly to be phosphate-free (Weiler)⁵, but this has now been submitted to re-analysis and proves to contain 0.8-1.0 per cent (Roche). Assuming that the dissociation constant for the tyrosine apo-decarboxylase-coenzyme complex is of the same order as that determined indirectly for pyridoxal using inactive whole organism⁸, it is possible to calculate the approximate yield of 'pyridoxal phosphate' from the curve for the recombination of tyrosine decarboxylase in two preparations; the yield of 'pyridoxal phosphate' calculated on this basis represents approximately 0.1 per cent of the pyridoxin used.

TABLE 2 STABILITIES TO ACID AND ALKALI OF CODECARBOXYLASE AND 'PYRIDOXAL PHOSPHATE' Activities expressed as units codecarboxylase/ml preparation estimated against tyrosine apo-decarboxylase⁵

Treatment	Codecarboxylase Units/ml	'Pyridoxal phosphate' Units/ml
Initial (untreated)	32	23
After 1 hr at 100°C		
(a) in 0.1 <i>N</i> NaOH	31	24
(b) in <i>N</i> NaOH	31	20
(c) in 0.1 <i>N</i> H ₂ SO ₄	11	7

Failing the isolation of the active substance in pure state, it is not possible to assign a formula to it with certainty, but from the nature of the reaction described above, it seems probable that 'pyridoxal phosphate' bears a phosphoryl residue on the primary hydroxyl group of pyridoxal.

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¹ Gale, E F, and Epps, H M R, *Biochem J*, 38, 232 (1944)

² Epps, H M R, *Biochem J*, 38, 242 (1944)

³ Epps, H M R, *Biochem J*, 39, 42 (1945)

⁴ Taylor, E S, and Gale, E F, *Biochem J*, 39, 52 (1945)

⁵ Gale, E F, and Epps, H M R, *Biochem J*, 38, 250 (1944)

⁶ Gale, E F, *Biochem J*, 34, 846 (1940)

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¹⁰ Snell, E E, *J Biol Chem*, 154, 313 (1944)

¹¹ Harris, S A, Heyl, D, and Folkers, K, *J Biol Chem*, 154, 31 (1944), *J Amer Chem Soc*, 66, 2088 (1944)

Effect of Change of Coat on the Growth of Epidermal Warts in Mice

THE paper on the artificial production of coat colour in the albino rat by Haddow and others¹ throws light upon some observations, recently made, on the growth of epidermal tumours in mice in relation to the growth of the nearby hair. The results had already been written up and are as follows.

It is well known that epidermal warts in mice produced by painting with tumour-producing agents show periods when their growth-rate is reduced, their size diminished, or they may even temporarily disappear. Having occasion to observe the growth of hair near warts for other purposes, it was noted that diminution in growth of the warts occurred when in black mice the surrounding skin, normally pale, became pigmented as it does when the hair bulbs are enlarging preparatory to the formation of new coat. In white and pale-coloured mice, this early growth of the hair bulbs cannot be seen, and the onset of a new coat shows itself later by the appearance of new hair.

The correlation between pigmentation of the skin in black mice and diminished growth of the warts is shown in Fig 1.

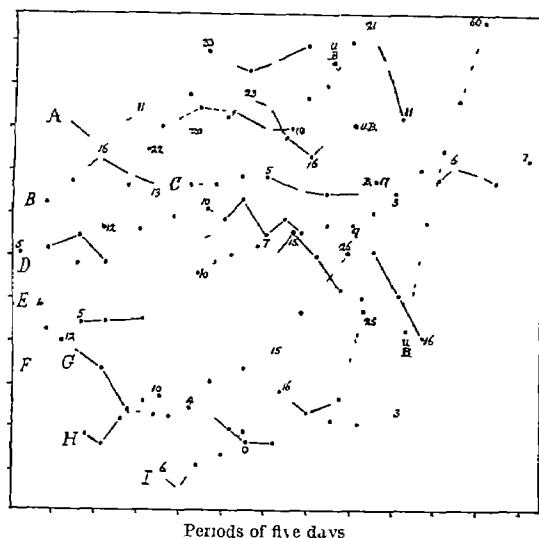


Fig 1 THE FIGURE SHOWS THE SUPERFICIAL DIMENSIONS (MAJOR AND MINOR AXES) OF EPIDERMAL WARTS IN BLACK MICE, PRODUCED BY PAINTING WITH BENZOPYRENE, PLOTTED AGAINST TIME. DOTTED LINES INDICATE TIMES WHEN THE SKIN AROUND THE WARTS WAS UNPIGMENTED AND FULL LINES WHEN IT WAS PIGMENTED. THE NUMBERS ON THE LINES GIVE THE AREA OF THE WARTS IN SQ. MM.

Times of pigmentation are clearly associated with arrested growth of the warts. Bleeding (B) and necrosis (U) of the warts also have this effect (see warts E and I). Wart H disappeared for a short time at O. The periods of pigmentation are about a week in duration.

Many warts are of a full pink colour during life, as soon as the surrounding skin became pigmented, it was noticed that they changed from pink to white or bluish-white, suggesting that their blood supply had been greatly reduced. Sections were therefore made of the skins of black mice in various stages of hair growth, and it was found that the capillaries surrounding the hair bulbs were widely distended with blood when they were actively growing. When forming pigment at the same time, it was found that the capillaries of the dermal papillae were

much less in evidence than in skins in which the hair bulbs were quiescent.

The conclusion was drawn that the growing hair bulbs caused a diversion of blood to them and away from the overlying epidermis and warts, hence their blanching, their lowered growth-rate and diminution in size.

If a rosy and a blanched wart be ligatured during life, fixed and sectioned, there is seen a great difference in the extent to which the capillaries and venules are distended with blood, sufficient to account for the considerable diminution in size and the complete flattening out of small warts.

The number of mitoses in the epidermis was counted before, during and after hair growth, and it was found that the number was greatly reduced during the time when the hair bulbs were actively growing. Details of these findings are given in Fig 2.

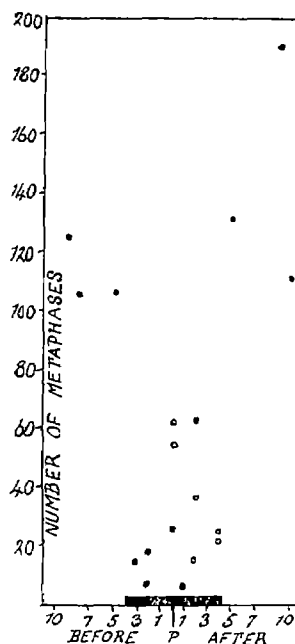


Fig 2 THE FIGURE SHOWS THE NUMBER OF METAPHASES PER 100 MM. OF SECTIONS OF SKIN 7 μ THICK ON DAYS BEFORE, DURING AND AFTER PIGMENTATION OF THE SKIN (P) IN PREPARATION FOR A CHANGE OF COAT. ALL SPECIMENS WERE TAKEN AT 10 A.M. TO AVOID DIURNAL VARIATION. THE BLACK BLOCK INDICATES THE DURATION OF PIGMENTATION.

This inhibition of mitosis is presumably the result of the lessened blood supply to the epidermis. Though a lowered rate of mitosis can account for the warts growing more slowly, it cannot account for their diminution in size as can the collapse of blood vessels.

Thus was independently observed the close correlation between hair growth and dilatation of the local capillaries, described by Haddow. He suggests that variation in blood supply controls hair growth, but it may be the reverse, that hair follicles stimulated to grow call forth capillary dilatation. In either case, secondary effects follow a diminution of blood supply to the epidermis and a temporary lowering of epidermal cell division.

The way in which new coats of hair spread gradually across the skin, as described by Haddow, for the rat, was also seen in the mouse. In the mouse there is a lateral line down the flank, well seen in black and tan mice, along which new coats of hair start and spread either dorsally or ventrally, not both ways.

at any one time. When mice are painted on the flanks with single applications of benzpyrene, the yield of tumours is affected by the condition of the hair at the time of painting, but because the spread of the new coat is very easily disturbed, for example, by plucking the hair or even by clipping it, controlled conditions are difficult to maintain. This confirms Haddow's finding that coat change is easily disturbed.

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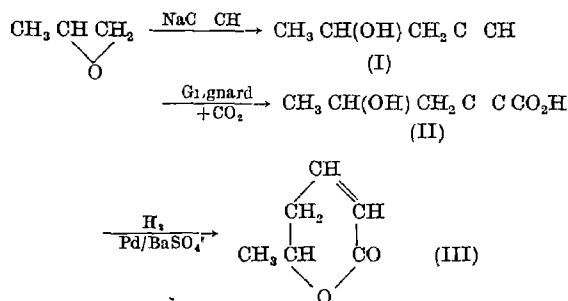
Mount Vernon Hospital,
Northwood, Middlesex.
April 3

¹ *Nature*, 155, 379 (1945)

Synthesis of the Differential Growth Inhibitor, δ -Hexenolactone

Two years ago, Medawar, Robinson and Robinson¹ described the isolation from a commercial malt extract of small quantities of a steam-volatile substance which inhibited the growth of fibroblasts and other mesenchyme cells at concentrations which permitted the free growth of epithelial tissue. It seemed probable that this material was an unsaturated lactone, $C_6H_8O_2$, and it was found that synthetic specimens of *dl*- δ - $\Delta^{\alpha\beta}$ -hexenolactone (III) (the *d*-form of which occurs in the fruit of the mountain ash) exhibited similar inhibitory properties, although the activity was rather less than that of the natural inhibitor. The differential growth-inhibitory properties of this lactone have since been confirmed by other workers².

The *dl*-lactone (III) was synthesized in small yield by Medawar, Robinson and Robinson by condensation of acetaldehyde with malonic acid in pyridine solution, and Kuhn and Jerchel³ obtained it from β - δ -dibromocaproic acid by boiling with water, the overall yield from sorbic acid being about 25 per cent. We have now found that the lactone can be prepared readily as follows:



Condensation of propylene oxide with sodium acetylidyde in liquid ammonia gives the carbinol (I) in 50 per cent yield. Treatment of the carbinol with two equivalents of ethylmagnesium bromide followed by carboxylation with carbon dioxide under pressure results in a 75 per cent yield of the crystalline hydroxy-acetylenic acid (II), m.p. 59°, which on semihydrogenation employing a 0.3 per cent palladium-barium sulphate catalyst gives *dl*- δ - $\Delta^{\alpha\beta}$ -hexenolactone directly, as a colourless stable oil, the overall yield from propylene oxide being about 35 per cent. The constants of the lactone are in agreement with those recorded by Kuhn and Jerchel³, and it exhibits the expected growth-inhibitory action*.

* We are indebted to Sir Robert Robinson and Dr Medawar for a report on the inhibitory properties.

This synthesis has the advantage of being readily adaptable to the preparation of related lactones, and these lines are being actively pursued.

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¹ *Nature*, 151, 195 (1943)² Kuhn, Jerchel, Moewus, Moller and Lettke, *Naturwiss.*, 31, (1943), Hauschka, T. S., *Nature*, 154, 769 (1944)³ *Ber. Chem. Ges.*, 76, 413 (1943)

Metabolism of Quinine in Chick Livers

In a recent paper Oldham, Kelsey, Cantrell and Geiling¹ reported that in White Leghorn chicks doses with quinine the concentrations of alkaloid in tissues were lower in young chicks than in grown birds. They suggested that quinine was metabolized more rapidly in chicks than in older birds. *In vivo* experiments by these workers on the quinine oxidase activity of the tissues, however, failed to show any activity in the liver, and showed only very slight activity in the kidney.

In similar experiments on quinine oxidase activity we have been able consistently to demonstrate definite activity in chick livers (strain Rhode Island Red $\times$ Light Sussex). Moreover, the activity increased with increasing age, as shown in the accompanying table. Chick embryo livers and whole embryos show a very high activity.

Material	Mean quantity of quinine (micrograms) metabolized in 2 hours by 0.5 gm. tissue
Whole embryo (10 day) (wt. unknown)	7.0
Embryo liver (10 day)	216
" (20 day)	154
Chick (1 day old)	87
" (1 week old)	97
" (2 weeks old)	69
" (4 weeks old)	94
Chicken (8 weeks old)	53
" (17 weeks old)	45
" (26 weeks old)	19
" (3 years old)	26

The discrepancy between our observations and those of Oldham *et al.* might be partly due to the fact that we used the phosphate buffered salt solution of Krebs and Henseleit² instead of ordinary Ringer-Locke solution, and also raised the temperature of incubation to 40° C to correspond with the body temperature of the birds. In one experiment on the liver from a three-week-old chick in Ringer-Locke, only micrograms of quinine were metabolized. Other causes of the difference of results might be differences in the strain of birds used, or dietary variations. We have in some cases experienced large variations in the quinine oxidase activity among birds of similar age.

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¹ Oldham, F. K., Kelsey, F. E., Cantrell, W., and Geiling, E. M. *J. Pharm. and Exp. Therap.*, 82, 349 (1944)² Krebs, H. A., and Henseleit, K., *Z. physiol. Chem.*, 210, 33 (1943)

Meiosis in Tropical *Rhoeo discolor*

MEIOSIS in *Rhoeo discolor* growing under temperate conditions has been described by Bhaduri¹, Darlington^{2,3}, Sax⁴, Sax and Anderson⁵ and by Kato⁶, but the last-named author's work has not been available. An examination of two collections of tropical material, (1) from St Augustine, Trinidad, and (2) from the Botanic Gardens, Port of Spain, has revealed certain interesting features which are reported below. Metaphase associations are given in Table 1, for the two collections separately.

TABLE 1 METAPHASE ASSOCIATIONS IN *Rhoeo discolor*

Coll	Ring of 12	12	10-2	Chams			other	Total
				9-3	8-4	6-4-2		
(1)	6	9	3	3	1	3	15	40
%	15.0	22.5	7.5	7.5	2.5	7.5	37.5	100
(2)	5	10	3	2	3	2	5	30
%	16.7	33.3	10.0	6.7	10.0	6.7	16.7	100

In the first collection, none of the rings of twelve and two only of the chains were disjunctionally arranged, while the corresponding figures for the second collection were one and five respectively. Thus in only 5 per cent of PMC's of the first collection and in 20 per cent of the second were there found disjunctional associations of twelve chromosomes. These figures indicate a considerably higher degree of irregularity than was found by Sax and Anderson⁵ and Darlington², who stated that rings occurred with a frequency of about 30 per cent, angle chains about 45 per cent, and that a "bare majority" were disjunctionally arranged. Sax⁴ gave no details about association but noted that pairing was variable, that chains were more common than rings and that about half of the first divisions examined were disjunctional.

It would be interesting to know whether these differences are genetic or merely environmental in origin, particularly as Sax⁴ found varying degrees of synapsis at lowered temperatures. Such variation emphasizes the dangers attendant on comparison of association frequencies estimated without any control of environmental error (cf Myers and Hill⁷, Benitez⁸ for review of environmental control of pairing, etc.).

An examination of cells between anaphase and telophase, that is, phases of separation in which the chromosomes could still be separately distinguished, yielded the following data (Table 2), in which are given the frequencies of the various types of separation observed, six to each pole, seven to one and six to the other, six to one and five to the other with laggard, etc. In addition, a very few cells were seen with bridges but no fragments; they may be due to inversion crossing-over (Darlington³, Bhaduri¹).

TABLE 2 ANAPHASE-TELOPHASE DISJUNCTION

Coll	6-6	7-5	6-1-5	6-2-4	6-3-3	7-1-4	5-3-4	5-2-5	Total
(1)	8	1	2	-	1	-	-	-	12
%	66.7	8.3	16.7	-	8.3	-	-	-	100
(2)	37	11	12	2	-	1	1	2	66
%	56.1	16.7	18.2	3.0	-	1.5	1.5	3.0	100

It will be seen that, in the two collections, 25.0 to 27.2 per cent of cells respectively contained at least one lagging chromosome (cf the 45 per cent found by Bhaduri¹). There was a well-marked inter-

phase in which complete despiralization took place. In a total of 438 interphases and first telophases in which despiralization had occurred, only 17 (3.9 per cent) were seen in which a chromosome had not been included in one of the polar nuclei, a very marked reduction compared with anaphase. This is no doubt due to the relatively very great volume of the resting nuclei; it must be rare that a lagging chromosome is so placed that it avoids inclusion in the expanding nucleus, once despiralization starts. The few chromosomes that were not so included remained condensed, a situation which has been found in *Tradescantia bracteata* (Darlington³) and *Tripsacum latum* in which an alternative behaviour was the formation of micronuclei (Dodds and Simmonds⁹). It may be surmised that the failure of despiralization is connected with the failure of loss of nucleic acids (cf Darlington¹⁰), and it is suggested that a study of the behaviour of such excluded chromosomes in favourable material might prove helpful in the study of the nucleic acid cycle.

The presence of an interphase is interesting since Sax⁴ stated that "the chromosomes retain their individuality during interkinesis", thereby presumably implying that there was no interphase despiralization. Again, it would be interesting to know whether this is a genetic or environmental difference.

Second division appeared normal, but a few diads were seen in which one cell was at second telophase and the other had not divided at all. In view of the normally high degree of synchronization between cells of a diad, it is possible that such cells represented failure of the second division and might thus have given rise to diploid spores. One second metaphase was seen in which were present two chromosomes apparently joined end-to-end and which had presumably failed to disjoin at the first division. This failure of separation is in accord with the observation of Darlington² but constitutes an exception to his statement¹¹ that undivided associations generally separate during an interphase.

I wish to thank Dr K. S. Dodds for helpful criticism in the preparation of this note.

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¹ Bhaduri, P. N., *J. Genet.*, **44**, 73 (1942).

² Darlington, C. D., *J. Genet.*, **21**, 207 (1929).

³ Darlington, C. D., *J. Genet.*, **35**, 259 (1938).

⁴ Sax, K., *Cytologia*, **3**, 36 (1931).

⁵ Sax, K., and Anderson, E., *Genetics*, **18**, 53 (1933).

⁶ Kato, K., *Mem. Coll. Sci. Kyoto Imp. Univ.*, Ser. B, **5**, 139 (1930).

⁷ Myers, W. M., and Hill, H. D., *Bot. Gaz.*, **104**, 171 (1942).

⁸ Benitez, L. M., *Amer. J. Bot.*, **31**, 428 (1944).

⁹ Dodds, K. S., and Simmonds, N. W., in the press.

¹⁰ Darlington, C. D., *Nature*, **149**, 66 (1942).

¹¹ Darlington, C. D., "Recent Advances in Cytology" (1937).

Plant Nutrients in the Sea

I HAVE recently been attempting a valuation of potential fish production of the banks of the Seychelles-Mauritius arc. The figures following indicate that the suggestion to increase the fertility of suitable parts of the sea by the addition of fertilizers¹ is an established process in certain places and circumstances in the ocean.

The estimated annual basic total catch (catch from professional fishermen only) of the Mauritius fisheries is 1,650 metric tons derived almost entirely from

135 square miles of coastal water, of which 25 square miles is partially reserved by the prohibition of net fishing. The average annual catch is thus rather more than 12 tons per square mile. I believe that the area is fished to the limit of productiveness, so that this figure (area-year production) really has some meaning. The number of professional fishermen is estimated at 1,200–1,500, giving a man-year production (from the more favourable figure) of 1.38 tons. It is interesting to find that a return taken at random from the fisheries census just completed gives the estimated catch of a basket-trap fisherman for the year, excluding Sundays only, as 1.58 tons, which is probably very close to the figure calculated from the totals when the other non-fishing days are taken into consideration.

Figures for Rodriguez, 350 miles to the east of Mauritius, suggest an area-year production of 5.8 tons per square mile and a man-year production of 1.48 tons. The area is not fished to its capacity.

According to Hornell², the Seychelles area of 12,000 square miles, worked by seven hundred fishermen (a "moderate" estimate), produces 1,100 tons, giving a man-year production of 1.57 tons and indicating a very slight exploitation of the enormous fishing area.

In a private communication, written at the end of 1943, G. C. L. Bertram, then chief fisheries officer, Palestine, commented on the "extremely small" catch of the fishermen there—"well under two tons per year on the average".

The similarity of the man-year production figures suggest that the productiveness of the grounds and the other factors—methods of fishing, nature of the fishermen, frequency of bad weather, and so on—are similar in all these places. The intensity of exploitation differs. Five tons per man per year was postulated by Bertram³ for the 'productive' fishery of the south coast of Arabia. This fishery, however, depends on sharks (south-west monsoon, April to September) and then on sardines (October to March), the latter with their large and voracious followers, the tunnies, bonitos and kingfishes. It is a pelagic fishery comparable in its results with the drift-net fisheries of northern waters rather than with the normally laborious process of capturing bottom fishes with hooks and lines.

The islets, reefs and shoals of St Brandon (Cargados Carajos) lie 220 miles north-north-east of Mauritius. The Raphael Fishing Company of Mauritius operates there with about a hundred men who fish with hooks and lines for approximately six months of the year (I give these notes and figures by courtesy of Mr Coucaud, of the Company). From the production of salt fish the man-year production of fresh fish must be at least 8.4 tons. One of the best fishermen brought in, during fifteen days of fishing in August 1944, no less than 798 kgm—a rate of more than 18 tons annually. I say these men work for six months at fishing, for the other six months they are digging guano! The area is about 1,000 square miles of shallows, but only a few favoured localities are fished, so that the area-year production of less than half a ton per square mile indicates slight exploitation only.

The solution, reactions and precise effect of natural guano in the sea have yet to be studied. In the light of certain other facts, a practical application at Mauritius can be projected, and as the argument in its favour bears on the point raised by Dr Atkins⁴ and answered by Prof Ritchie⁵ I make no apology

for summarizing it here. Rapid dissipation into the ocean from the narrow coastal belt around tropical oceanic islands appears likely—as likely indeed as it does from the middle of the North Sea. But many of the economic species of fishes of these islands feed directly on vegetable matter (seaweeds and fixed species of diatoms), so that the conversion of fertilizer into fish is an even more rapid process than that outlined by Prof Ritchie. There is another factor—conservation. Experiments with surface drift bottles off Bermuda in 1932 and 1933 (as yet unpublished) showed a centripetal surface drift during the winter months and a stabilized 'saucer' of warm water oscillating about the islands in the summer, both due to temperature and thermal currents of the shallow waters in and around the islands. In the absence of storms, the coastal water is thus pinned to the land with the pelagic eggs, larval and post-larval stages of the marine organisms, including the fishes, contained therein. Fertilizer spread between tide-marks on such islands as Bermuda and Mauritius would, in my opinion, have little chance of dissipation, but the movements of the inshore waters both here and elsewhere require extensive investigation.

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March 14

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² Hornell, J., Rep. on Fisheries of the Seychelles Islands (192).

³ Bertram, G. C. L., private communication.

⁴ Atkins, W. R. G., *Nature*, 154, 490 (1944).

⁵ Ritchie, J., *Nature*, 154, 832 (1944).

Longevity of *Schizophyllum commune*

In October 1909 the late A. H. R. Buller collected at Winnipeg fresh fruit-bodies of the xerophilic agaric *Schizophyllum commune* Fr. and placed them in his laboratory. On December 10, 1910, a number of whole or part piles were sealed in glass tubes in vacuum of less than 0.1 mm. pressure of mercury and stored in the dark at room temperature^{1,2}. E. F. notes, found recently at Kew with the remaining tubes, show that he planned to test the vitality of the fungus after 1 week, 6 weeks, 4 months, 1, 2, 4, 5, 6, 10, 15 and 25 years. Tradition and experience rate the life of a mushroom as short. Actually, I opened only four tubes: the fungus revived after 1 week, 3½ months, 16½ months, and after 19 months the last three weeks of which were spent at a temperature of liquid air, as noted below.

On March 5, 1945, I opened a tube containing five parts of pilei, moistened them, and placed them in a damp chamber. All expanded, but four of the parts failed to shed spores. The fifth formed a sporangium within a day, and continued to shed spores until it was removed after three days. The spores were normal for the species, 6–7.5 × 2μ, asymmetric and when placed in water some of them germinated. Sections of the gills of this fan-shaped piece of pile 25 mm. long and 15 mm. wide at the edge when moist, showed normal basidia, sterigmata and spores in various stages of development.

Another tube was opened on March 8, 1945, and its contents (one small pileus and a part of a pile removed with sterile forceps, moistened with sterile

ater, and placed on agar. The part-pileus was ad, but the whole one soon formed a spore print id, since there was very little contamination and actically every *Schizophyllum* spore germinated, I adily obtained pure cultures, the hyphae of which veloped clamp-connexions. The living pileus was moved from the agar after two days, placed on a ide in a damp chamber, remoistened and moved ch day. It continued to produce spores sufficient o make a visible spore-print until March 31. Mean- hile rudiments of new pilei developed near the argin, one grew to 10×6 mm, and from its gills ores were shed so as to make a spore print from arch 23 until April 2. This total of 24 days of spore oduction may be a record for the species, at ast it shows that the fungus had maintained its tality.

A few of the remaining fruit-bodies collected during ctober 1909 were taken by Dr Buller to Birming- am where, on June 5, 1912, they were sealed in a ry high vacuum "at about the X-ray stage".¹ I ened one of these tubes on March 1, 1945, it ntained two pieces of pilei, one of which shed ores normally when moistened.

Two or three of the vacuum tubes of 1910 were ken by Dr Buller to Birmingham and immersed liquid air (-190°C) for three weeks in 1912. One as then opened, as noted above. I opened another 1 March 8, 1945, it contained one piece of pileus hich shed spores normally. I obtained pure cultures so from these spores.

Eleven of the vacuum tubes remain for future sts. The four opened each contained a specimen ill living $35\frac{1}{2}$ years after it had developed, $34\frac{1}{2}$ (or, i one instance, $32\frac{3}{4}$) years of which were spent *in cuo*. This is a noteworthy maintenance of 'sus- ended vitality'. Additional evidence is provided in vour of Buller's theory³ that an agaric which sheds ores is alive, and that spores discharged normally e capable of germination.

I do not know whether anyone has tested recently e retention of vitality in *S. commune* kept in 'dry' r. Buller¹ reported that pilei exposed to the u- ally dry air of a room in Winnipeg were still alive ter $6\frac{1}{2}$ years. A pileus collected at Canterbury on ebruary 1, 1935, and filed in Kew Herbarium, re- ved after moistening on March 7, 1945, and shed ormal spores.

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April 16.

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uller, A. H. R., and Cameron, A. T., *Trans Roy Soc Canada*, 6,
Sect 4, 73 (1912)
uller, A. H. R., "Researches on Fungi", vol 1, p. 105 (1909)

Anther and Petal Colour of Potato Varieties

WHILE anther colour has long been used as a agnostic character in the identification of potato arieties, there is a lack of agreement in some of the blished descriptions of the colours. Thus both avidson¹ and Salaman² describe the anther colour e variety Majestic as 'orange' and that of Arjan ctory as 'pale yellow' and 'yellow, pale' respectively, uch indicates some degree of agreement in their e of colour description. Nevertheless, Salaman

refers to the anther colour of Up-to-Date as 'yellow, pale', while Davidson describes it as 'orange'.

To ascertain whether the differences were due to ariation in the anther colour, or to inconsistency in describing it, the colours of the anthers of several arieties from various sources, and, in the majority of cases in two or more years, were matched, after removal of the petals, against the Horticultural Colour Charts issued by the British Colour Council in collaboration with the Royal Horticultural Society in 1939 and 1942. The anther colour of some varieties was found, in fact, to exhibit a certain amount of ariation although the limits of such variation were usually not wide. Its range is given in the accompa- ing table, the number of years over which the exam- inations extended being placed in parentheses after the name of the variety. The name of the colour is in each case followed by its reference number, the number in bold type being that of the full hue of which the colour given may represent a tint, shade or greyed hue.

Petal colours were determined at the same time, and these are also included in the table. Primrose yellow potato flowers are normally described as white.

ANTHER AND PETAL COLOUR OF POTATO VARIETIES		
Variety	Anther colour	Petal colour
Arran Banner (1)	Saffron yellow 7	Primrose yellow 60 1/3
Arran Peak (2)	Saffron yellow 7	Primrose yellow 60 1/3
Arran Pilot (2)	Buttercup yellow 5 to saffron yellow 7	Mineral violet 6 35/1 to Dauphin's violet 0 39/1
Arran Victory (2)	Buttercup yellow 5 to saffron yellow 7/1	Primrose yellow 60 1/3
Ballydoon (2)	Lemon yellow 4 to buttercup yellow 5	Primrose yellow 60 1/3
British Queen (2)	Lemon yellow 4	Primrose yellow 60 1/3
Catrina (2)	Aureolin 3 to lemon yellow 4	Mauvette 5 37 to Dauphin's violet 0 39/2
Di Vernon (2)	Buttercup yellow 5/1	Spectrum violet 7 35/1 to violet 36
Doon Star (1)	Buttercup yellow 5/1	Primrose yellow 60 1/3
Duke of York (1)	Aureolin 3/1	Primrose yellow 60 1/3
Dunbar Standard (2)	Buttercup yellow 5/1 to buttercup yellow 5	Primrose yellow 60 1/3
Eclipse (1)	Empire yellow 60 3	Primrose yellow 60 1/3
Epicure (1)	Buttercup yellow 5	Primrose yellow 60 1/3
Gladstone (2)	Buttercup yellow 5 to chrome yellow 60 5	Primrose yellow 60 1/3 to primrose yellow 60 1/1
Great Scot (1)	Indian yellow 6/1	Primrose yellow 60 1/3
Kerr's Pink (3)	Lemon yellow 4 to buttercup yellow 5/1	Primrose yellow 60 1/3
Majestic (2)	Saffron yellow 7	Primrose yellow 60 1/3
Ninetyfold (1)	Aureolin 3	Primrose yellow 60 1/3
Red Skin (1)	Saffron yellow 7	Primrose yellow 60 1/3
Sharpe's Express (2)	Lemon yellow 4	Rose purple 5 33/1 to pansy violet 00 33/2
Up-to-Date (3)	Buttercup yellow 5/1 to Indian yellow 6	Mauvette 5 37 to Dauphin's violet 0 39/3

The relation between the colours in the table and those in common use is illustrated by the classifica- tion provided with volume 2 of the Horticultural Colour Charts. This shows the gradation of yellow colours from 'greenish yellow' (Dresden yellow 64—the last of the 64 full hues and therefore, on a circular arrangement of colours, adjacent to sulphur yellow 1) through 'yellow' (lemon yellow 4) and 'orange yellow' (saffron yellow 7) to 'yellowish orange' (tangerine orange 9), and of violet colours from 'reddish violet' (orchid purple 31) through 'violet' (violet 36) to 'bluish violet' (methyl violet 39).

W G BURTON

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Cherryhinton,
Cambridge

¹ Davidson, W. D., "Potato Growing for Seed Purposes" (Dublin Stationery Office, 1937)

² Salaman, R. N., "Potato Varieties" (Cambridge, 1926)

VISCOSITY AND LUBRICATION

AT a joint meeting of the Institute of Petroleum and the British Rheologists' Club, held at Manson House, Portland Place, London, W 1, on April 18, five papers dealing with different aspects of flow problems were discussed. Prof E N da C Andrade, president of the British Rheologists' Club, and Prof F H Garner, president of the Institute of Petroleum, were the chairmen for the two sessions of the meeting.

Dr G Barr presented a paper on "The Precision and Accuracy of Viscometry Using BSI Tubes". The paper dealt with data on viscometry collected by the Institute of Petroleum and analysed by Prof Garner and Dr A H Nissan. U-tube viscometers conforming to BSI specifications were sent to a number of laboratories in Europe, the United States and Britain with three oils, with requests to determine flow-times of the oils in the tubes supplied. Further, each laboratory was invited to report the kinematic viscosity of the oils in absolute units at 20° C, according to the method used in the laboratory and country concerned. As a result of analysis of the results returned by some of the laboratories—the outbreak of war prevented many from doing so—it was concluded that dimensional specifications of viscometric tubes were not sufficient to ensure agreement between tubes for the same oil in the same laboratory of better than 0.1 per cent. To ensure such a high degree of agreement a 'dynamic quality control test' is suggested in which flow tests are made on a number of viscometers in order that master tubes may be selected from a set of apparently equally good tubes.

In comparing the viscosity of the oils as measured by British and American methods, it was found that there was a consistent deviation of 0.35 per cent between the two countries. In the discussion it was suggested that the variation in g in different countries might influence the apparent value of the unit of kinematic viscosity in different countries and possibly account for the difference between the American and British determinations. It has since been pointed out by Dr Nissan, however, that the viscometer tubes were calibrated by liquids of known viscosity, and therefore g does not enter into the calculation of these results.

The dynamic control test was criticized in that U-tube viscometers which were found satisfactory by time of flow tests on two reference oils might not be satisfactory for times of flow different from those used for calibration, it would therefore be advisable to use more than two reference oils for calibration of viscometers in the dynamic flow test. The accuracy required in viscosity determinations is to some extent influenced by the determination of viscosity index—a measurement of viscosity variation with temperature—which was discussed in a later paper, the determination of viscosities with a maximum error of 0.1 per cent brings in many factors imperfectly controlled or understood at the present time. Among these factors, in so far as the reference oils are concerned, are thermal and mechanical hysteresis or the solution of air in oil. The influence of errors in timing including that of the operator was discussed. Dr Barr pointed out that in changing from an aqueous solution to a hydrocarbon oil anomalies have been observed which are difficult to explain. If a No 3 BSI tube is used for the determination of a hydrocarbon oil and calibrated at intervals with the 60 per cent sugar solution, difficulties are experienced in

obtaining consistent times of flows, even when the tubes have been very carefully cleaned between the oil and sugar-solution tests. It is difficult to imagine what effect can produce this result, as any retainer film must be much too small to affect the dimensions of the tube.

The second paper dealt with "The Testing of Greases for Ball-Bearings" and was presented by Mr S R Pethrick. It was emphasized that conventional methods for testing greases are of little assistance in the selection of greases for particular applications. It was suggested that tests on lime-base greases should include (1) flow measurements at various rates of shear and at various temperatures; (2) an oxidation test with an examination of the oxidation products, and (3) a syneresis test involving capillary action. Soda- and lithia-base greases vary widely in texture, cohesion and adhesion, and some method of measuring these properties is desirable. The author described an apparatus using the torque exerted on the housing of a ball-bearing rotating under controlled conditions and lubricated by the grease, as a measure of the cohesion, adhesion and lubricating properties of the grease. The stability of the grease can also be determined in the same apparatus by churning it first and then measuring the torque under standard conditions.

The present standard methods of test for greases such as penetration or drop point, while of value for routine checking of a particular product, do not render it possible to select a grease for a particular application without a full-scale test in the equipment to be lubricated.

The development of bearing tests for greases should enable such a selection to be made much more readily and might lead to a more precise definition of physical properties which can be characterized by fundamental measurements.

It was suggested that, in the main, greases are used at moderate temperatures at fairly high speeds and that such conditions should supplement those suggested by Mr Pethrick.

The second half of the session was opened by a paper on "A Rational Basis for the Viscosity Index System. Part I", by Mr E W Hardiman and Dr A H Nissan. The viscosity index of an oil is given as a comparison of the drop in its viscosity between 100° and 210° F with those of two oils, one of low variation in viscosity with temperature (H series) and another of high variation (L series) for the same temperature range. Thus

$$\text{Viscosity Index} = \frac{L - U}{L - H} \times 100,$$

where U is viscosity of the oil at 100° F, cs , L and H are viscosities at 100° F of the series L and H oils respectively, having the same viscosity at 210° F as the oil under test, cs .

Tables were issued by the originators of the V.I. (viscosity index) system from which L and H can be read. This system has been adopted as a standard method for petroleum oils both in the United States and Great Britain. It appears that, for viscosity index values exceeding 140, the value of the index obtained from the tables and this equation are not unique solutions, since two oils both having the same viscosity at 100° F but very different values of viscosity at 210° F can give the same viscosity index. The authors presented a method whereby the index can be calculated as

*Viscosity Index = $(60.0 - \text{antilog } n) \times 3.63$,

where
$$n = \frac{\log U - 0.4336}{\log \text{viscosity at } 210^\circ \text{F}}$$

This viscosity index is a single-valued function. Furthermore, this scale does not differ fundamentally from the Dean and Davis original V.I. system between 100 and 140, but corrects its anomalies above 140. The viscosity index scale was criticized because it is not directly connected with the temperature slope and also because it is not additive as regards mixtures, but it was pointed out that the law of mixtures for viscosity even of pure liquids is as yet not fully understood. From the viscosity index and viscosity at one temperature, it is possible by the use of charts, such as that issued by The American Society for Testing Materials, to ascertain viscosities over a range of temperature, and with a modified scale suggested in the paper this can be done with oils of very flat viscosity-temperature curves such as are now being made by the employment of special additives to lubricating oils. The scale can be applied to oils with no change in viscosity with temperature which would have a viscosity index of around 200 and even to oils which show an increase in viscosity with rise in temperature. The modified scale to be of value in characterizing one of the more recently developed lubricants for which the original viscosity index scale is not satisfactory, it must be adopted as a standard method by such bodies as the American Society for Testing Materials and the Institute of Petroleum Standardization Committee.

Dr. A. Lahiri presented a paper on "The Problem of Engine Deposits", by Dr. E. W. S. Mardles and himself. The paper is an extensive report on rheological and other colloidal studies of oils under oxidizing conditions simulating very closely those existing in internal combustion engines. The oxidizing apparatus can be used as a rotating viscometer of the Stormer type. Studies of specific viscosity have revealed the probable shapes of dispersions in aero-engine oils. The work with the rotating viscometer on oxidized oils has shown that rigidity develops slowly at first with time, then the oxidizing oil suddenly gellates when the concentration and polymerization of the oxidized products reach a critical value. The tendency of oils to keep in suspension soot or other dirt has also been studied. In general, a high degree of flocculation of carbon black, etc., results in high specific viscosity, high sedimentation-rates and times, high rigidities and yield values of the dispersion.

In the discussion it was pointed out that performance tests on lubricating oils for use in internal combustion engines have been extensively developed on engines of different types, but it was felt that these tests are not complete unless information can be derived from the used oils in addition to that obtained from the condition of the engine after the test. The work described in the paper suggested a simple and logical approach to this problem. In the selection of temperatures used for the oxidation tests described, the authors used thermocouples inserted at various points in pistons of aero-engines, and found that the temperature at which the oil functions is of the order of 200–300°C, and hence the fact must be faced that oxidation takes place at such temperatures. Within this range of temperatures there is, however, a marked difference in the behaviour of the oil, thus for the same oil at 200°C gelation

developed in 40 hours, whereas at 235°C 5 hours was sufficient. For the chromatographic examination of used oils columns of 2 in. diameter and 6 ft. long have been used with various adsorption media such as activated silica.

The final paper was presented by Dr. A. S. C. Lawrence on "Lubricating Greases". Lubricating greases are mixtures of soaps dispersed in oil. If a soap is mixed with a hydrocarbon at low temperatures, it exists as a solid suspension. At a certain temperature T_1 , the system assumes a gel structure which it maintains up to another critical temperature T_2 , when it becomes a fluid solution of soap in the hydrocarbon. Peptizers may be used to change suspensions of soap in oil into gels. A tentative structure of the gel by co-ordination was given. The rheology of greases was very briefly given.

Attention was directed to the paucity of information on the temperature-flow relations of greases, although such information would be of direct practical interest and also of great value in determining the energy of flow of the different phases in grease.

The importance of rate of cooling on the structure of greases was emphasized in the discussion, which largely centred about the application of knowledge gained in the investigation of soaps for pure fatty acid to commercial grease manufacture. The character of the mineral oil used is a factor of importance, and certain types of refined oils are unsuitable. Although the water content of greases is very low, and cannot be detected readily by electrical conductivity measurements, it plays an important part in peptization, that is, in increasing the degree of dispersion. It is possible that it acts as a hydrolyser of the soap and that the most effective peptizer is stearic or other fatty acid.

It was pointed out that although greases prepared from more than one metal may result in loss of consistency, in practice lime and soda greases and extreme pressure greases containing lead and calcium are found to be required industrially. Pure anhydrous sodium soaps of the fatty acids have probably never been prepared, although aluminium tri-stearate can be prepared and forms gels as do the other aluminium stearates.

All the papers and discussions reported here will be published in a separate volume by the Institute of Petroleum.

DENTAL HEALTH IN BRITAIN

THE Interim Report of the Interdepartmental Committee on Dentistry (Cmd. 6565, H.M. Stationery Office, 1944) records this Committee's opinion that the dental health of Britain is bad and that its effect upon general health is also bad. The dental profession itself cannot be blamed for this. Its ideals are high. They see in dentistry, not merely attention to teeth, but also that basic relation between dental disease and general ill-health which is the basis of the scheme of dental education outlined by C. Bowdler Henry (*Lancet*, 26, Jan. 6, 1945), who advocates a basic medical education for dental students and also the education of stomatologists who would act as consultants to dentists and would study dental problems in relation to other diseases and to the general biology of man. But the best dental profession in the world cannot operate in a vacuum, it must have the respect and co-operation of the people whom it seeks to serve, and the facts

recorded in this report show that the British people not only do not take full advantage of the public dental services which now exist, but also they do not appreciate the effects of dental disease upon their general health.

As a preface to the discussion of this unsatisfactory position, the Committee outlines the history and present position of the dental profession and its educational and research facilities. Dental education in Britain is given in five dental schools in London, seven in the English provincial cities (Birmingham, Bristol, Leeds, Liverpool, Manchester, Newcastle and Sheffield), three in Scotland (Dundee, Edinburgh and Glasgow), one in Northern Ireland (Belfast) and four in Eire. Before the War, these schools had a capacity of 2,000-2,500, most of them were staffed largely by teachers on a part-time basis, paid or honorary, and some four hundred students a year entered the schools, of whom about 10 per cent were women. Students could prepare for either the B.D.S. degree or for the somewhat lower standard of the licence (L.D.S.), the majority took the licence, the courses for which occupied about five years, while those for the degree were rather longer. Most of the schools have some facilities for research, but most of the staff have little time for this. The dental hospitals provide treatment for the poor and clinical teaching for the students, but neither the hospitals nor the schools have enough money for expansion and improvement. Refresher courses and a limited number of hospital posts provide some post-graduate training. Figures supplied by the Government Actuary indicate that most of the dentists admitted to the register by the 1921 Act are now older than forty-five, so that there will be, in the next few years, a rapid loss of names from the Register by retirement, and the average annual rate of entry to the Dental Register in recent pre-war years in Great Britain was about 340, while the annual rate of entry of students has fallen to below three hundred, some 10 per cent of whom do not, for various reasons, become dentists. It is therefore clear that the Register cannot be maintained even at its present strength. Even if the annual number of persons entering the profession rose to 400 between 1948-52 and to 425 thereafter, it would still be thirty years before the present effective total of the profession would be increased. This is indeed, as this report puts it, an alarming forecast.

Nor is this Committee satisfied with the present position of ancillary dental workers, namely, dental dressers, dental attendants and dental mechanics. The dental mechanic is an essential part of any dental service, and the existing arrangements for the training of dental mechanics are inadequate.

Considering remedies, the Committee concludes that the greatest single step forward would be the creation of a single comprehensive dental service equally available to all who demand it, and paid for by the community as a whole. This service should be an integral part of the Government's national health service, it would give the dental profession its rightful place in the public estimation and would encourage the much-needed recruitment to the profession. In such a scheme certain classes of people, namely, nursing and expectant mothers, children and adolescents, require special attention, and a big expansion of dental services for school-children is one of the essential foundations of a comprehensive health service. All local authorities responsible for schemes of dental health should appoint, as some do

now, a chief dental officer with adequate powers. Quotations from statements made by local authorities show that they are aware of the importance of the responsibilities in this respect.

No dentist, the report insists, should be compelled to enter the public service and all should be able to leave it if and when they desire to do so. Dentists should also be able to engage in whole- or part-time public dental service and in any branch of it. A patient must have free choice of the dentist a liberty to change to another at will. The right of private dental service should especially be preserved. General dental practitioner service should be broad and analogous to that of general medical practitioner service. Dental health centres should be established; they might be experimental at first, the local dentist being consulted about their organization, design and equipment, this participation by dentists in the planning of the dental health centres is emphasized by the report, which would extend it to the planning and administration of the whole dental health scheme.

The report emphasizes the importance of education of the public in dental health. A definite policy of education of the public is required, which should include high quality of dental treatment, education at the health centres, dental hygiene in the school, the encouragement of children to accept treatment, education at maternity and child welfare centres, a supply of publicity material from central sources. The report concludes with the recommendations that suitable ex-Service men and women should be encouraged to become dentists, that dental teachers should be recalled from service as soon as possible, and that dental equipment now being used in the Services should be made available for the public dental service.

The unanimity and brevity of this report enhance its value. Its recommendations should be widely known, for without the intelligent co-operation of the public no health scheme can succeed.

METCHNIKOFF CENTENARY CELEBRATIONS

A MEETING was held at the Opera House in Moscow on May 15 to celebrate the centenary of Metchnikoff's birth, it was opened by G. Miterov, the Soviet Commissar of Public Health. A great gathering of representatives of the medical profession and bacteriology had come together to honour the memory of the great Russian man of science and philosophy.

Ilya Metchnikoff was one of the first Russian Darwinists, and proved by his experimental work the existence of general laws of evolution applying to animal organisms. His biological research on comparative embryology led him to problems of pathology and medicine, in which he obtained epoch-making results, formulating a theory of phagocytosis. After working for a long time at the Pasteur Institute in Paris, he became head of a new school of microbiology investigating especially problems of immunity as it affects medical practice, particularly vaccination. During the latter part of his life, Metchnikoff gave much attention to the study of old age, longevity and death. His point of view was that people do not live so long as they should do, and that, by appropriate modes of living, life could be considerably lengthened.

The role of Metchnikoff in science was the subject of a special paper read by Vassili Parin, general secretary of the Academy of Medical Science. "Metchnikoff," he said, "who obtained such important results in his theoretical work, did not despise practice and gave much time to find a scientific basis for fighting infections and epidemics such as cholera, phoid and tuberculosis. His philosophy was full of optimism and faith in humanity and in the final triumph of science."

Metchnikoff died in 1916, but his numerous pupils in the Soviet Union pursued on a large scale his microbiological research for the welfare of the people. The Opera House meeting was the first of a series of conferences extending over several days, at which reports were presented on various problems of bacteriology, and papers read on Metchnikoff's philosophical conceptions and his work in the fields of arminism, zoology, embryology, immunity, parasitology, microbiology and epidemiology.

To mark the centenary, the Soviet Government has decided to erect a monument to Metchnikoff in Moscow and to put memorial tablets in the University of Kharkov, where he was a student, and in the University of Leningrad, where he lectured. The University of Odessa, where he occupied a professorial air, will bear his name. Metchnikoff gold medals and prizes are to be awarded by the Moscow Academy of Sciences, and Metchnikoff scholarships for students and research workers are to be founded by the Academy of Medicine and by the Medical Institutes of Kharkov, Moscow, Leningrad and Odessa.

A biography of Metchnikoff is to be published, together with a uniform edition of his complete works, and a film on his life and work will be issued in 1946.

LYDIA BACH

SCIENTIFIC AND INDUSTRIAL RESEARCH IN CANADA

A PRELIMINARY review of the work of the National Research Council of the Dominion of Canada in 1944, issued by the Research Plans and Publications Section, in addition to indicating the way in which the Council organizes and co-ordinates its national co-operative research programmes, outlines a few of the major items in the work under the Council's direction.

In aerodynamics, some of the new work involves such problems as balancing of controls on aircraft, work on aircraft skins, the design of tailless aircraft and investigation of factors which arise in their operation. In hydrodynamics there are two main fields—model-testing and basin-tests on aircraft hulls and seaplanes, and hydraulic studies on harbour and river problems, in which such factors as silting, tidal effects, turbulence, location of piers, etc., are involved. Much test work is done on aircraft engines, and unsuspected savings in aviation fuel consumption have been achieved by developing a new type of cracked fuel which can be used in place of straight gasoline in certain operations. Photography has been utilized to study droplets in clouds surrounding aircraft in flight, and physical chemistry has shown the way of dispelling the raindrops which fall on the aircraft's turret and tend to obscure his vision. In the field of applied biology, war requirements have placed great emphasis on the need for work on

foods and their preservation and methods of transport. The development of canning methods for chicken, pork and ham has been undertaken as part of the war effort, and the industrial utilization of agricultural products is an important branch of work. The shortage of rubber led to the study of fermentation methods for the production from wheat of butylene glycol, recently shown to be useful as an anti-freeze, as well as a basis for the production of many useful chemicals. Methods are being developed for modifying wheat starch as a substitute for other starches and for the production of syrups and sugars. A pilot plant using a mechanical method for extracting resin rubber from native plant materials such as milkweed is in full operation.

The activities of the Division of Chemistry have involved much research on adapting substitute materials to war requirements and in developing new methods for strategic chemicals. Substantial advances have been made in the technique of rot-proofing, flame-proofing, and water-repellency treatment of fabrics. The synthesis of new toxic compounds has been carried on as part of the programme of the Directorate of Chemical Warfare and Smoke. Alkaloids from Canadian plants continue to receive attention, and the Paint Laboratory has been occupied with the development of new protective coatings. A new method of glueing based on electrical resistance has been developed and is in commercial use. Research on the prevention of corrosion by the use of inhibitors is continuing, as well as on the protection of aluminium alloys against sea water. Work has also been carried out on the photo-sensitized polymerization and hydrogenation of butadiene.

In the Division of Physics and Electrical Engineering much work has been done during the War on the detection of sound under water at ultra-sonic frequencies. The General Physics Laboratory facilities have been used in such problems as measurement of muzzle vibrations of rifle bullets, ballistics cameras, vibrational measurements, construction and testing of fire-control apparatus, counter chronographs, automatic plotter for air-ground training and other work for the Armed Services. Much work of the Heat Laboratory has been suspended, but infra-red studies and work on land-mine detectors have been carried out with success. The Optics Laboratory has made a substantial contribution to the war effort, and can claim a fair share of credit for the establishment of an optical glass industry in Canada, besides contributing largely to aerial photography. The radio staff has grown to several hundreds, with special laboratories constructed to meet demands for radar studies, and post-war applications may include air-navigation methods, improved blind-landing technique, compact recognition equipment for all types of ships and aircraft and new types of shore beacons to supplement lighthouses, anti-collision alarm signals, etc. Industrial radiology has opened up a wide field of inspection which has been applied in the non-destructive detection of flaws in metal. The X-ray diffraction study of materials is becoming increasingly useful as new techniques are discovered, and electron microscopy is also providing the physicist and chemist with fundamental data not previously attainable.

The National Research Council has devoted much time and thought to preparation for the post-war period, and, under pressure of war, Canada is already spending five times as much on research as in the pre-war years.

FORTHCOMING EVENTS

Tuesday, June 19

ROYAL PHOTOGRAPHIC SOCIETY (SCIENTIFIC AND TECHNICAL GROUP) (at 16 Prince's Gate, London, S W 7), at 6 p.m.—Mr H. K. Bourne "Photographic Light Sources" (lecture-demonstration)

Wednesday, June 20

GEOLOGICAL SOCIETY OF LONDON (at Burlington House, Piccadilly, London, W 1), at 3 p.m.—Scientific Papers

ROYAL ENTOMOLOGICAL SOCIETY (joint meeting with the ROYAL METEOROLOGICAL SOCIETY) (at 41 Queen's Gate, London, S W 7), at 4.30 p.m.—Major H. C. Gunton, M.B.E. "Phenological Relationships of Meteorology and Entomology" Dr C. B. Williams "Fluctuations in Insect Populations as related to Weather Conditions" Dr A. E. Slater "Vertical Air Currents as Agents of Insect Dispersal" Dr B. P. Uvarov "The Organization of Biochemical Research"

Thursday, June 21

LINNEAN SOCIETY (joint meeting with the ZOOLOGICAL SOCIETY) (at the Linnean Society, Burlington House, Piccadilly, London, W 1), at 4.30 p.m.—Major Albert Pam, O.B.E. "The Snake-Venom Serum Institute in San Paulo, Brazil", Mr C. H. Locket "The Availability of Water to Plants in Chalk", Mr W. B. Dowson "The Habits of some Fishes of Nigeria"

Friday, June 22

INSTITUTION OF MECHANICAL ENGINEERS (joint meeting with the MANUFACTURE GROUP) (at Storey's Gate, St James's Park, London, S W 1), at 10.30 a.m. and 2.30 p.m.—A Series of seven Short Papers

PHYSICAL SOCIETY (OPTICAL GROUP) (in the Physics Department, Imperial College, London, S W 7), at 3.30 p.m.—Dr A. F. C. Pollard "Instrument Design"

APPOINTMENTS VACANT

APPLICATIONS are invited for the following appointments on or before the dates mentioned

LECTURER IN PHYSICS at the Burnley Municipal College—The Director of Education, Education Offices Burnley (June 20)

LECTURER IN BIOLOGY, with honours degree in Zoology, at the South-East Essex Technical College, Dagenham—The Clerk to the Governors (June 20)

LECTURER IN CHARGE OF ZOOLOGY (not Botany, as previously stated) at University College, Leicester—The Registrar (June 20)

LECTURERS IN GENERAL ENGINEERING SUBJECTS and in ELECTRICAL SUBJECTS at the South-West Essex Technical College, Walthamstow, London, E 17—The Clerk to the Governors (June 23)

LECTURER IN PHYSICS at the Leicester College of Technology—The Principal (June 23)

A LECTURER IN MECHANICAL AND MARINE ENGINEERING, and a LECTURER IN ELECTRICAL ENGINEERING, at the Marine School of South Shields—The Principal (June 25)

DEPUTY LIBRARIAN at University College, Gower Street, London, W C 1—The Secretary (June 25)

PLANT PATHOLOGIST in the Research Division, Department of Agriculture and Forests, Sudan Government—Ministry of Labour and National Service, Central (T and S) Register, Room 5/17, Sardina Street, London, W C 2 (quoting F 4139 A) (June 26)

ASSISTANT LECTURER IN AGRICULTURE and an ASSISTANT LECTURER IN AGRICULTURAL BOTANY in the University College of Wales, Aberystwyth—The Registrar (June 26)

LECTURER IN FOODSTUFFS in the Manchester Municipal College of Technology—The Registrar (June 30)

A PLANT PHYSIOLOGIST, a PLANT ECOLOGIST, a MICROBIOLOGIST and a FOREST ECONOMIST, in the Department of Forestry, University of Oxford—The Professor of Forestry, Imperial Forestry Institute, Oxford (June 30)

ASSISTANT LECTURER IN THE DEPARTMENT OF METALLURGY, University of Liverpool—The Registrar (July 5)

LECTURER IN ENGINEERING in the Department of Civil and Mechanical Engineering, University of Glasgow—The Secretary (July 9)

TWO UNIVERSITY DEMONSTRATORS IN BIOCHEMISTRY in the University of Cambridge—The Secretary, Appointments Committee of the Faculty Board of Biology "B", University Physiological Laboratory, Downing Street, Cambridge (July 9)

A WOMAN ABSTRACTOR (Ref No F 4217 XA), and two PHYSICAL CHEMISTS with research experience in Rheology or Surface Chemistry (Ref Nos F 4218 XA and F 4219 XA) for a Research Association—Ministry of Labour and National Service, Central (T and S) Register, Room 6/17, Sardina Street, London, W C 2 (quoting appropriate reference number) (July 12)

SPECIAL LECTURER IN BIOCHEMISTRY in the University College of Wales, Aberystwyth—The Registrar (July 15)

LECTURER IN GEOGRAPHY, with special qualifications in Cartography, in the University of Reading—The Registrar (July 16)

STRATHCONA-FORDYCE PROFESSOR OF AGRICULTURE in the University of Aberdeen—The Secretary (August 31)

AN OFFICIAL FELLOW AND TUTOR IN ECONOMICS at Magdalen College, Oxford—The Secretary to the Tutorial Board (Sept 1)

TWO OFFICIAL FELLOWS AT NUFFIELD COLLEGE, Oxford, for research in ECONOMICS AND POLITICS—The Warden (Sept 1)

PROFESSOR OF ELECTRICAL ENGINEERING at King's College, London, W C 2—The Academic Registrar, University of London, Richmond College, Richmond, Surrey (Sept 17)

ABSTRACTORS for articles in foreign languages at the Imperial Bureau of Animal Health, Veterinary Laboratory, New Haw, Weybridge—The Deputy Director

PROFESSOR OF PHYSICS at Canterbury University College, Christchurch, New Zealand—The Secretary, Universities Bureau of the British Empire, c/o University College, Gower Street, London, W C 1
SENIOR ASSISTANT AT THE IMPERIAL BUREAU OF HORTICULTURE AND PLANTATION CROPS, East Malling Research Station, near Maidstone, Kent—The Bureau

LECTURER IN ENGINEERING SUBJECTS at the Medway Technical College, Gillingham—Form of application from Divisional Educational Officer, Fort Pitt House, Rochester

LECTURER IN SOCIAL STUDIES in the University of Edinburgh The Secretary to the University Court

PROFESSOR OF PHILOSOPHY in Natal University College, Pietermaritzburg—The Secretary, Universities Bureau of the British Empire, c/o University College, Gower Street, London, W C 1

CHIEF ANIMAL HUSBANDRY OFFICER, and an ASSISTANT ANIMAL HUSBANDRY OFFICER, for the Berkshire War Agricultural Executive Committee—The Secretary of the Committee, 1 Abbot's Walk, Reading

REPORTS and other PUBLICATION

(not included in the monthly Books Supplement)

Great Britain and Ireland

A Report to the Government of India on Scientific Research India By Prof A. V. Hill Pp 55 (London Royal Society 1945) 1s

National Parks in England and Wales A Report to the Ministry of Town and Country Planning By John Dower Pp 58 (London H. M. Stationery Office, 1945) 1s net

Proceedings of the Edinburgh Mathematical Society Series Vol 7, Part 2. An Integral Formula for $Q_n(\cos \theta)$, by E. T. Cossar, A Generalisation of Certain Properties of Laguerre Polynomials by B. Skettharasa Sastry, The Cesàro Summability of Four Integrals, by J. Cossar, The Geometrical Construction of Masche Quartic Surfaces, by W. L. Edge Transposed Algebras, by I. M. Etherington Pp 24 (London G. Bell and Sons, Ltd, 1945) 1s

Report of the Marlborough College Natural History Society for the Year 1944 Pp 28 (London Cambridge University Press, 1944) 1s 6d net

Resistance in Norway By Diderich Lund Pp 10 (Enfield W. Resistors International, 11 Abbey Road, 1945) 2d

Ministry of Food Scientific Advisers Division Manual of Nutrition Pp 64 (London H. M. Stationery Office, 1945) 1s net

Diamond Tool Patents for Machining Metals and Non-metallic Substances By P. Grodzinski and W. Jacobsohn Pp 16 (London Diamond Trading Co., Ltd, 1945) 1s 6d

Transactions of the Royal Society of Edinburgh Vol 54, Part No 13 A New Cephalopod Fish from the Downton of Scotland with notes of the Structure and Classification of Ostracoderms Dr T. W. Westoll Pp 18+4 plates (Edinburgh and London Oliver and Boyd, Ltd, 1945) 4s 9d

A Find of the Early Iron Age from Llyn Cerrig Bach, Angles Interim Report by Sir Cyril Fox Pp viii+64 (Cardiff National Museum of Wales, 1945) 7s 6d

Science and Religion By Prof Herbert Dingle (Modern Pamphlet on Religion, Life, and Thought, No 5) Pp 24 (London Union Modern Free Churchmen, 1945) 6d

Other Countries

Soviet Calendar, 1945 Pp 280 (Moscow Foreign Language Publishing House, 1945)

Pre-war Production and Distribution of Narcotic Drugs and Raw Materials By L. T. Atzenwiler (League of Nations Publication No 11) Pp 32 (New York International Documents Service Columbia University Press, London George Allen and Unwin Ltd, 1944) 50 cents

American Association for the Advancement of Science Publication No 22 A Symposium on Mammary Tumors in Mice By Members of the Staff of the National Cancer Institute Pp vi+123 (Washington, D.C. American Association for the Advancement of Science, 1945) 4 dollars

U.S. Department of Agriculture Farmers' Bulletin No 19 Planning the Farm for Profit and Stability By Neil W. Johns Pp 30 (Washington, D.C. Government Printing Office, 1945) 10 cents

U.S. Department of the Interior Annual Report of the Secretary for the Fiscal Year ended June 30th, 1944 Post-War Frontiers edit Pp xxxvi+321 (Washington, D.C. Government Printing Office, 1944) 45 cents

U.S. Office of Education Federal Security Agency Statistical Summary of Education in the United States, 1941-1942 By E. M. Foster Pp 42 Bulletin 1944, No 2 Education of Youth for Improving Majority-Minority Relationships By Ambrose Cahill Pp 65 15 cents (Washington, D.C. Government Printing Office, 1944)

Carnegie Institution of Washington Year Book No 43, July 1943, to June 30th, 1944, with Administrative Reports thence December 15th, 1944 Pp xxiv+208 (Washington, D.C. Carnegie Institution of Washington, 1944)

University of Missouri Studies Vol 20, No 1 The Ecology of the Prairie Chicken in Missouri By Dr Charles W. Schwartz xii+82+32 plates (Columbia, Mo. University of Missouri, 1945) 1.50 dollars

Catalogue

"No-Loss" Energy Regulators for A.C. or D.C. Control Description Application, Circuits, Sizes, Mounting and Prices (Sunvic Publication 12/2) Pp 10 (London Sunvic Controls, Ltd, 1945)

NATURE

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FIELD STUDIES IN BRITAIN

TO some, in particular to the young reared more or less exclusively in an urban environment, the rising hum of the machine age is as music in the ear—enticing, exciting, novel. Contemplation of mechanical achievement induces a pleasing impression of man's inventiveness, his sense of finding ways and means, his ability to triumph over all kinds of difficulties in the interest of utility.

Our present purpose, however, is not to discuss the merits or demerits of this trend in human affairs, but to indicate that there are other trends which have a special claim on our attention at the present time. In particular, attention may be directed to the advocacy, on many sides and by people of widely diverse background, of the need for encouraging and fostering a love of the countryside and of all the many interests and delights which it can provide for men of quiet mind. To some, perhaps, contact with country life is no more than an occasional need, the response to a passing nostalgic mood. To others it represents an escape from the grime and grind of city life. But these, on the whole, are negative aspects of the call of the countryside. The positive aspect is seen in the actions of those for whom life in the country, involving a close, personal contact with Nature, is regarded as both necessary and desirable because it provides something not to be found in town or city, something that is felt to be essential to the fullness of life.

No short description will cover the attractions which the English countryside can provide. To each one of us, according to his mind, it has something to offer. As our contact becomes more close and intimate, specific interests begin to take shape. These include what might be described as the general interests of the countryman, a combination of the æsthetic, the scientific and the utilitarian, and, more specifically, those of the field naturalist, the geologist, the geographer, the archaeologist and the landscape painter. On each of us the world of Nature, whether represented by the open downs, the moor, the fen, the forest or the shore, lays its spell. Not only do we advance our particular interest and broaden our general sympathies—we also acquire an outlook on life other than that which emerges from the urban daily round. It seems improbable that anyone will seriously dispute the desirability of fostering a knowledge and appreciation of the countryside (and all that this connotes) as part of the educational equipment of a nation that now professes to look forward to a better way of life. Nor will it be denied that it is to young people in particular that this opportunity should be given.

There is nothing new in the pursuit of field studies. No contemporary poem is necessary to extol the joy of the country life or the pleasures of contemplating wild Nature. But two things may perhaps be noted. One is that during the last few decades there has in fact, been a relative decline in field work. The other is that with the development of large towns and suburbs, young people are of necessity being brought up in an environment which daily becomes

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more and more completely removed from the realm of meadow and hedgerow. There is, then, a real need for a renewal of interest in field studies. There is also a very real practical problem, namely, how ways and means can be provided to make good this want. On page 744, we publish a paper by Mr. F. H. C. Butler, honorary secretary of the Council for the Promotion of Field Studies, in which the aims, objects, inception and achievement, of this Council are fully set out.

After a perusal of that article, we feel sure that many readers will desire to support the work of the Council by individual subscription and personal advocacy. Such support will be welcome. But the matter should not be allowed to rest at this level. It is not too much to say that the work of the Council, if it can be carried out on an adequate scale, will contribute both directly and indirectly to the national well-being. In that the field studies envisaged have a definite educational, cultural and practical value, they should be regarded as an integral part of the new movement in education. They should therefore be encouraged and promoted by all who realize the value of this work, while, at the administrative level, they should be supported by a grant from the Treasury commensurate with the proposals indicated in the Council's modest but well-considered plan of action. Further, in view of the fact that the Council's work will turn on the acquisition of appropriate centres spread over the country, it can show a good case for the receipt of capital grants. Here the larger philanthropic bodies might well consider whether the Council's objects do not come within their range of interests, and whether they cannot help in establishing the Council on the secure basis which its significance for the future seems to justify.

UNIVERSITY RECONSTRUCTION

The University and the Modern World

An Essay in the Social Philosophy of University Education. By Arnold S. Nash. Pp. 223. (London: S.C.M. Press, Ltd., 1945.) 12s. 6d. net.

THIS essay in the social philosophy of university education is in the nature of a tract for the times, and like most such tracts it is something of *un cri du cœur* and is apt to be stronger in criticism and diagnosis than in constructive suggestions. Mr. Nash faces the fundamental questions of the real function of the university in society which must be answered before we can determine finally its place in the organization and endowment of research or in the educational system as a whole. The problems he raises and discusses are more vital and searching than most of those which Mr. Brian Simon asked and, with the impatience of youth, did not stay to answer. Mr. Nash makes his diagnosis and writes a prescription, though whether the prescription can be made up, or whether its ingredients are available or potent, are matters on which opinion may differ widely.

As to the diagnosis, Mr. Nash is in good company. His main thesis, that the modern university has built up its curriculum and elaborated its educational procedures on the basis of an inadequate philosophy, and that some new unifying principle is needed, is reflected

in much current criticism of the universities. Lowe, for example, in "The Universities in Transformation", in a passage quoted by Mr. Nash, commented that our future intellectual leaders would not be able to understand, and still less to plan, more than a small fraction of social life, unless they knew how to link together the various aspects of their experience into a unity of knowledge. They can only carry out this process if they have learnt how to utilize the findings of the specialist sciences, and at the same time have acquired some direct experience of, say, the particular benefits and strains arising from industrial life, of Nature as reshaped by technique, of social responsibility as increased by planning.

The same thesis is to be found in a recent essay by Prof. John MacMurray on "The Functions of a University" in the *Political Quarterly* and in the 9th edition of Sir Charles Grant Robertson's "The British Universities". It is implicit also in B. Dobrée's essay on arts faculties in modern universities, though not all who recognize as consistently as Rashdall at Mansbridge the unifying influence of a true university would agree that the task of integrating the various branches of learning is specially the function of arts faculties.

Mr. Nash's argument elaborates at greater length this view that a university is not a university at all unless the various faculties and the subjects they treat gain unity of purpose and aim by some common view of man's nature and destiny. It is the substance of his indictment of the liberal democratic university in the first part of his book that the liberal university failed to supply such a view. By rejecting any attempt to discover and then to teach a unified conception of life, the liberal university ceases to be a university, and in the second part of the book Nash argues that students on the continent of Europe embraced Nazism and Communism so readily because the totalitarian philosophies appeared to present only one option to the confusion and chaos of liberal world view which regards each academic subject as autonomous.

In these two parts of his book Mr. Nash writes with unmistakable courage and sincerity. His analysis is impartial, but there will be many who while accepting his view as to the disintegration of the university world and even that the university is facing a profounder crisis than that evoked by the Renaissance or the Reformation, will challenge his conclusions or diagnosis in respect of particular fields. What is at stake, he urges, is a question of the scientific tradition as opposed to the literary tradition as the basis of university education, but the adequacy of the common premise of any tradition now current in the liberal democratic world on the nature and function of the university in human society. Scientific knowledge of man and the universe does not, he holds, by itself provide adequate foundation for intellectual reconstruction, though a place must be found for it in the social structure, and he urges an attempt to discover the limits of reason and the range of validity of scientific method.

Neither that, nor his main thesis, is a new one, but in his discussion of the liberal university, Nash is inclined to attribute a larger place to science as a discipline in the universities than it has actually held. It may well be disputed whether the modern university has ever assumed that the scientific method and spirit are an adequate guide in the pursuit of knowledge. Only last January Sir Lawrence

agg welcomed the admission from the arts side of the six different, though interconnected, realms of intellectual activity of which an educated man would know something included at least the sciences of physics, biology and astronomy. So far from once having been given, at least in the older universities, the place as a discipline to which it is entitled, it may be held that it has been rather omitted on sufferance.

While accordingly it could be maintained that once should have a larger place as a cultural element in education at all levels than it occupies at present, Mr Nash's criticism of the inadequate philosophy of science and of the chaos of liberal atomism whereby the subjects of the university curriculum are separated from each other into neat departments of specialized knowledge is much easier to sustain. In two chapters on the rise and decline of scientific individualism, Mr Nash scarcely allows himself the grace to deal adequately with the issues, and these chapters are suggestive rather than conclusive. Even more challenging is his explanation in the second part of the book of the way in which European trends came to embrace the totalitarian philosophies. His linking of Nazism and Marxism together in this respect will not please all his readers. Both Nazi and Communist, he argues, are right in rejecting the assumption that science has no preconceived bias, in maintaining that knowledge must and does have some purpose greater than itself, and in concluding that all human knowledge is conditioned by irrational factors.

But while Mr Nash agrees with the totalitarian attempt to achieve a synthesis of the different dualisms that give a prominent place to political ideas and concepts by showing the political implications of different realms of specialized knowledge, he sets forthright the totalitarian attempt to unify realms of knowledge by making them subject to final categories and purposes, and by creating a scholasticism which puts the whole of knowledge in a totalitarian strait-jacket. He does not mean that the university must satisfy only the demands which society can make articulate. A university, he holds, discharges its obligations to the social order also by making society aware of what society ought to want. In other words, the breakdown and inadequacy of the three existing philosophies of the relations between the university and social order—what he describes as the spectator theory, the ambulance theory, and the participant theory—lead Mr Nash to advance what may be regarded as the prophet or interpreter theory, and essentially to this that he devotes the third part of his book.

Not even Mr Nash's sincerity renders this partly convincing, but he is himself conscious of its limitations and anxious to inspire a further attempt. In the further volume on "The Reconstruction of the University" which he has in preparation may deal more adequately with some of the questions raised, while Mr Nash is not alone in his plea that the university teacher must accept the responsibility for creation and teaching of a unified and coherent philosophy, and the task of creating a *Weltanschauung* which steers a middle path between liberal atomism and totalitarian dogmatism. Sir Charles Robertson held that theology should be restored to the position of the sciences in the original sense of the 'science', and others like Dr A. D. Lindsay urged that the universities must complete the

education provided in religion as fully and as essentially as in humanism and science if the spirit of the community itself is to be rescued from disintegration.

Mr Nash himself urges that Christian scholars must work out an adequate conception of religious education which, although giving meaning to the whole of knowledge, does not confuse the spirit of the age with the spirit of the ages. His main thesis is developed following a rather inadequate treatment of the sociology of knowledge, the chief value of which he finds in the truth of its thesis that there are fashions of thought which cannot be adequately understood so long as their social origins are obscure. He pleads for a fellowship of lay theologians or Christian scholars who would strive to create a Christian world view within which the conclusions of the specialized subjects of the university curriculum could be given their ultimate meaning in terms of a specifically Christian philosophy of man and of his relation to the historical process.

His plea for an intellectual synthesis for the twentieth century and an interpretation of human life and destiny with a moral or specifically Christian basis is sometimes tantalizing but never without dignity. His treatment of the philosophy of science is short—almost brutal—but Mr Nash is always stimulating. His defence of the freedom of science is sound, and he dispels false ideas in the controversy over science and planning as trenchantly as he does misconceptions of the importance of the university's task of witnessing to the value of the independent and critical pursuit of truth as such and not the buttressing of political or religious doctrines, or as to the entire objectivity or detachment of university thought or teaching.

The relevance of Mr Nash's present book to the problem of university reconstruction is in fact in just this challenge and stimulus to critical and constructive thinking on the philosophy of the university and the content and interrelation of its curricula. Out of such thought must come the creative proposals on which will be based any re-orientation of the functions of the universities to serve the new age. Mr Nash would not claim that he has given us the answers to the questions he raises. He claims that university life and teaching must have a moral and spiritual basis and unity, and is content to start us thinking. His book is a modest but useful contribution to that debate, and its value is increased by an annotated bibliography which, in spite of some surprising omissions—why is Bavinck ignored, for example?—is a useful starting point for wider reading. The production is scarcely in keeping with the quality of the matter and there are too many bibliographical slips for a book of this calibre. R. BRIGHTMAN

COSMOLOGICAL THEORIES

The Idea of Nature

By R. G. Collingwood. Pp. viii+184. (Oxford: Clarendon Press, London: Oxford University Press, 1945.) 15s. net.

COLLINGWOOD'S illness and early death prevented him from saying fully or as effectively as possible all that he had to say. Prof. Knox, the editor, points out that the work now published was written in 1933-34, after the "Essay on Philosophical Method", and was intended as an application of that method. Since the author did not publish anything at the time, we may infer that he was not satisfied

with it. In spite of some later revision it must be taken as no more than a substantial fragment. It suffers more than most of Collingwood's work from a tendency to rash statements and occasional labouring of small points. Nevertheless, the book is a valuable contribution to philosophy, and supplements what we have already of Collingwood's highly original and distinctive way of thought.

The central thesis is that cosmological theories at all periods are based upon analogy. Some familiar aspect of experience is taken as a clue to the character of the whole realm of Nature. Ancient Greek thinkers, almost without exception, conceived of Nature as a living organism. They drew no sharp distinction between the material, the living and the conscious, and they saw the orderliness of the natural world as an expression of its intelligence. After the Renaissance, when machines became familiar, it was conceived as a machine. "The word 'matter' had acquired a new sense: it was no longer the formless stuff out of which everything is made by the imposition upon it of form, it was the quantitatively organized totality of moving things" (p. 112).

Then comes the most challenging part of Collingwood's argument. Since the eighteenth century a new view of Nature has been displacing the older one, a view that does not stress permanence, but rather process, change, development. This means, according to Collingwood, that the natural world is conceived on the analogy of human history, whence these ideas are derived. There follow interesting comments on Hegel, Bergson, Alexander, Whitehead and others, showing how in their hands old conceptions have given place to others, but the process has not gone to completion.

It is here that one sees most clearly that Collingwood's own thought has not reached its own full development. Not only has he cut out the sketch of his own cosmology at the end, but also he has not co-ordinated the stages of the historical process to make clear the way older views have given place to later, as he should have done according to his theory of philosophical method. Moreover, there is only cursory treatment of one of the chief problems—how far at any stage of thought the natural world could be conceived as self-contained and self-subsistent.

Like all Collingwood's work, this book effectively jolts the reader out of common habitual modes of thought. The pity is that it is really no more than a fragment.

A. D. RITCHIE

SCIENCE AND CRAFT OF BEE CULTURE

A Manual of Bee-Keeping

For English-speaking Bee-keepers. By E. B. Wedmore. Second edition, revised. Pp. xxiv+389+9 plates. (London: Edward Arnold and Co., 1945.) 18s. net.

THE honey-bee has been more extensively and deeply studied than any other insect. The craft of bee-keeping has perhaps the most complex technique that has ever been developed for the domestication, or perhaps it is safer to say the exploitation, of any livestock. This is due to the highly developed social life of the bee, with its infinite variety of possible reactions to stimuli not always understood or controllable by man. It is not surprising, therefore, that

there is a very extensive literature dealing with science, art and craft of bee culture.

The author of "A Manual of Bee-Keeping" deals entirely with bee-life, its science, and the technique of bee-keeping, and does not interpolate extra from the classics or the poets. He deals in fact. After a life-time spent in research work, he has keen sense of scientific caution, and adroitly avoids giving unproved theories or indulging in flights of fancy. All the time he presents facts in clear, critical form. It is to be hoped that readers will appreciate that when the author of this book gives instructions for an operation involving a sequence of steps at intervals indicated in precise words, deviation from literal accuracy in taking those steps is allowed for, otherwise trouble will be encountered.

The general arrangement is encyclopaedic, and paragraphs are numbered—some 1,600 of them—with cross-references to all related subjects. There is nothing to tie the book to bee-keepers in one country and render it unsafe to use in another. It gives facts about honey-plants and current practice in both hemispheres, and general management of bees much the same all over the world, so that it may be described as of international application.

It is significant that among the traditional notions that the author discredits is the persistent belief that each baby bee that emerges from its cell leaves behind its cocoon skin adhering to the walls and base, so that the size of the cradle diminishes with each successive generation that uses it until only undersized bees can be reared. Much searching has had to be done to reveal any comb with cell walls more than thousandths of an inch in thickness, whatever their size.

Pollen, which was for so long regarded as a nuisance in the combs that writers used to give elaborate instructions for getting rid of it, receives full recognition of its value in no uncertain terms. So readers will be surprised to learn that well over a hundredweight of pollen is used annually in a normal bee colony, and that in summer the daily gathering of pollen may exceed two pounds. Annual consumption of honey will be about four hundredweight with some few gallons of water, so that the total food consumed by the bees is considerably in excess of a quarter of a ton per hive.

Bees have normally been cleared from filled spaces by boxes of honey by use of a device called a Porter escape, which causes the bees to walk between delicate springs through which there is no return long as nothing happens to jam the springs. The author illustrates a device of his own designing which has no movable parts to become fixed. It operates on principles similar to those employed in some crab traps.

The important discovery that bees will tolerate a space of about $\frac{1}{4}$ in. between frames of comb and sides and floor of the hive without filling it with wax was published in 1852 by L. L. Langstroth. It appears, however, from evidence adduced by Wedmore, that Debeauvoys published in 1851, in "Guide de L'Apiculture" a description of a space of 6 mm. which could be used in the same way, so he would appear to have anticipated Langstroth's announcement. There was, however, the difference that in France the discovery passed unnoticed, so that in the English-speaking world the American's made a great stir.

Altogether, Wedmore's "Manual" is a book for the serious student, for the practical man, and as a present to both classes.

H. J. WADSWORTH

Diseases of Vegetables

Bulletin No 123 of the Ministry of Agriculture and Fisheries By Lawrence Ogilvie Second edition 11+74+8 plates (London H M Stationery Office, 1944) 1s 6d net

THIS is the second edition of the now well-known bulletin on diseases of vegetables written by L. Ogilvie, advisory mycologist for the Ministry of Agriculture's western province, with headquarters at Long Ashton Research Station, Bristol.

Among the expert mycologists comprising the Ministry's team of advisers, no one is more fitted than Ogilvie to write this bulletin. His province includes five counties within the boundaries of which are to be found some of the best vegetable-growing areas, cultivated by some of the most progressive growers of market garden produce. Long years of experience coupled with his considerable number of investigations into many diseases of vegetables have won Mr Ogilvie such knowledge of the problems which arise in the successful cultivation of vegetables to render his advice extremely valuable to growers of these crops.

After a brief but lucid introduction explaining the nature of the various kinds of disease, the ones attacking vegetables are described and appropriate measures for preventing or checking them are given. The diseases are referred to by the accepted common name (standardization of which for Great Britain has been attempted in the List of Common British Plant Diseases recently published by the Cambridge University Press), but the full scientific name of the organism causing the disease also appears in brackets after the common name.

Compared with the first edition, there has been some revision and addition in the light of recent discoveries by research workers. There are a score or so of excellent photographs to illustrate some of the important diseases.

Following the main part of the bulletin dealing with vegetable crop diseases, there is a small but useful section giving descriptions of such practices as soil sterilization by steam and chemicals, seed treatment, preparation and use of fungicidal sprays and dusts, disinfecting of glasshouses, etc. There follows a list of the Ministry of Agriculture advisory mycologists with the counties administered by each; this is of great use in indicating where growers can apply for advice on crop troubles.

It is an extremely well set up publication which every grower of vegetable crops ought to have. The information it contains is written by an expert, and at a price, as usual with these bulletins, is within reach of everyone's pocket. D E G

Radio Technique

A G Mills Pp viii+170 (London Chapman and Hall, Ltd, 1944) 12s 6d net

Radio Receivers and Transmitters

S W Amos and F W Kellaway Pp x+281 (London Chapman and Hall, Ltd, 1944) 21s net

THE paucity of new text-books concerned with radio transmission makes the above pair particularly welcome. While we cannot subscribe to the claims of the first author that his text covers among other matters a thorough treatment of transmission and reception necessary for the complete understanding of radio, nevertheless what he has attempted

the young student in a restricted field is well done, and gives a very good idea of the theoretical

background necessary in every telecommunications engineer whether specializing in radio transmission or not.

The authors of the second book are slightly more ambitious, they link up the theoretical work with practice and bring in topics too numerous to mention here. There are many applications of valves which must wait for general disclosure, but this book will certainly impress the student that there are important applications of radio technique, and that to understand them—and in the future to introduce new ones—it is necessary for him to learn much relevant fundamental work. The authors, while not exhausting the subject, have made a careful selection which can be recommended with confidence. L E C HUGHES

Organic Reagents for Organic Analysis

By the Staff of the Research Laboratory of Hopkin and Williams, Ltd Pp 172 (London Hopkin and Williams, Ltd, 1944) 5s 6d

ESSENTIALLY a summary of a good deal of information hitherto available only in a dispersed form in recent chemical literature, this book provides a comprehensive list of organic reagents which may be used in identification work for the preparation of crystalline derivatives of various organic types. To illustrate its scope, we may note that under the alcohol type are given eight 'selected reagents' and eleven 'other reagents', the former being as a rule more satisfactory and easier of access than the latter, for details of which the reader is referred to the original literature. Choosing 3,5-dinitrobenzoyl chloride as a typical 'selected reagent', we find a description including its structural formula, molecular weight and significant properties, with experimental details for its use in preparing derivatives of alcohols and phenols, together with notes on other applications, a bibliography, and references to tables of melting-points given at the end of the volume. To name a less familiar example, xanthidrol is described, on a similar plan, as a reagent for amides, urethanes, sulphonamides and substituted barbituric acids. There is a good index.

The book is evidently an outcome of much first-hand experience, and will be a valuable adjunct to teachers, students, research workers and others concerned with qualitative organic analysis. J R

Bentley and Driver's Textbook of Pharmaceutical Chemistry

Revised by Dr John Edmund Driver Fourth edition Pp ix+644 (London, New York and Toronto Oxford University Press, 1945) 21s net

THIS book is widely used by those who have passed preliminary scientific examinations and are studying for the qualifying examinations in pharmaceutical chemistry. Its suitability for this useful purpose is attested by the appearance of four editions in twenty years. It is divided into three sections dealing with analytical methods, inorganic chemistry and organic chemistry respectively, and is full of facts clearly and simply set forth. A large proportion of these facts is taken from the "Pharmacopoeia", with suitable explanations and amplifications. A few references are given to original papers, but the book is essentially an elementary textbook for a specialized purpose. The new edition has been brought up to date by the inclusion of data from the first six addenda to the "British Pharmacopoeia" of 1932 and revised throughout in the interests of accuracy and clarity.

THE COUNCIL FOR THE PROMOTION OF FIELD STUDIES

By F. H. C. BUTLER

Honorary Secretary

IN all branches of knowledge which deal with the nature or configuration of the earth, or with its animal or plant population, or with human ecology, past and present, teaching cannot be adequate unless the student can learn in the field as well as in the lecture-room, library and laboratory, this is equally important whether he is to become a teacher, an administrator or a research worker. It is difficult, often impossible, to carry out adequate field excursions from school or university. The time taken in travelling to and from any but the nearest localities leaves little opportunity for serious work, the carriage of apparatus and equipment is also a major problem. Moreover, in research it is often necessary that continuous observations in the field should be carried out over long periods, this is essential where the subject-matter of a problem is so great that its adequate investigation will take many years, for example, the detailed geological or geographical study of selected areas, or the study of fauna and flora. It is equally essential where seasonal changes are all-important, such as the effect of weather on coastal configuration, or the observation of seasonal changes in the fauna and flora of the sea, lakes and rivers, or on the land. A great deal of the biological field-work done at present loses much of its value because of the impossibility of making regular observations in the same area throughout the year.

In order to meet such difficulties on an adequate scale, the Council for the Promotion of Field Studies was founded in 1943, a report of the inaugural meeting was given in *Nature* of December 18 of that year. A leaflet was issued by the Council last June giving a brief description of its aims, membership, proposed constitution and current activities. In February this year the first number of the *C.P.F.S. Bulletin* was published. The aims of the Council are to provide facilities for every aspect of field-work at first-hand, and to set up for this purpose residential field study and research centres, distributed throughout Britain, in localities selected for the richness and variety of their ecological features, geological and geographical interest and archaeological and historical importance. The field centres will be available alike to all serious workers in the field, whether amateur or professional, whether as individuals or as members of a class from a school, training college, university, young people's college, youth club, or other corporate body. The Council wishes to co-operate closely with local societies and field clubs, and through the centres—many of which will be situated in or near Nature reserves or national parks—should be able to play an important part in the training of the community in sound knowledge, æsthetic appreciation and proper use of the countryside.

The Council is working in close co-operation with the National Trust, which is fully in sympathy with its proposals. It is hoped to establish the field centres so far as possible by leasing National Trust properties, care being taken in their adaptation and use to ensure their preservation as national monuments, while at the same time putting them to a cultural purpose. For the establishment of the first field centre, the

National Trust in 1943 made an offer to the Council of the lease of Flatford Mill and Willy Lott's Cottage in East Suffolk, made famous by Constable, an admirably suited to scientific and artistic studies. Prof. W. A. F. Balfour-Browne made a generous grant to cover the first year's rent, and application was made in June 1944 to the Carnegie United Kingdom Trust for a capital grant towards the considerable cost of adaptation and equipment. The Trustees expressed their interest in the aims of the Council and agreed to contribute up to £2,000 for this purpose. Negotiations with the National Trust for the lease of this property have therefore been concluded, and when labour and materials become available the work is to be carried out under the professional direction of Mr. Marshall Sisson, who has been appointed consulting architect to the Council. The family of the late Miss Alice Hibberd Ware has generously presented her unique collection of natural history material for the use of students at Flatford. It is hoped to dedicate the library to the memory of James Reid Moir, the well-known Ipswich field archaeologist, who did so much of his scientific work in the neighbourhood and who lived in the Mill House for the last five years of his life; he greeted the foundation of the Council for the Promotion of Field Studies with enthusiasm and his help would have been invaluable.

It is the unanimous view of the Executive and General Committees of the Council that the success of its scheme depends on the possibility of establishing a number of field centres in different parts of Great Britain more or less simultaneously as soon as possible after the general conclusion of world hostilities, to be followed by others as occasion and opportunity offer. The general demand for property suitable for centres is rapidly increasing, for the Council's needs their precise location is of paramount importance on ecological grounds, it is therefore essential that the Council should be in a financial position to take urgent selective action before it is too late, as present opportunities are never likely to recur. Regional sub-committees covering England and Wales have been appointed to advise the Executive Committee on the selection of suitable sites, with the requisite accommodation for centres in their areas. Mr. Hubert Smith, chief agent of the National Trust and a member of the Council executive committee, is kindly advising the sub-committees when suitable Trust properties become available.

In addition to the grant from the Carnegie Trust the University of Cambridge, on the recommendation of three faculty boards (Biology 'A', Geography and Geology, Archaeology and Anthropology) and the General Board of Studies, has agreed to put the capital sum of £600 at the disposal of the Council towards initial expenses incurred in establishing field centres. The University of Bristol and the University of Leeds have allocated token annual grants and donation has been received from University College Hull. Owing to the unique opportunities for teaching study and research in the field that will be made available to them as the centres become established the Council looks to each of the other universities for at least token financial support at the earliest possible moment. As the Council's work will involve the management and ownership of property, with gradually increasing financial responsibilities the Executive Committee considers it essential that the Council should become incorporated under the Companies

times Act, 1929, and the necessary application is being made. Under the constitution, the General Committee of the Council will be the statutory body responsible for the formulation of policy, the direction of activities and the election of the executive. It is composed of representatives appointed by the universities, scientific societies and institutions, leading organizations of the teaching profession and the main groups of natural history societies, field and club. The Council's work will embrace very wide and varied interests, and, in order to be fully representative, the General Committee must necessarily be a large and influential body; it is clear that equality in the election of official representatives cannot be reached until the Council gets into its stride, and it is important that this should be borne in mind. It is proposed that one quarter of the General Committee should be representatives of individual members.

At the first meeting of the General Committee held in the Royal Society's meeting room on April 25 the following resolutions were passed unanimously:

(1) This representative meeting strongly urges the great potential value of the work of the Council in the scientific, educational and cultural importance of taking immediate measures to establish a number of field centres actively in operation in different parts of the country.

(2) That the Executive Committee be instructed to take immediate measures to put this view before appropriate Government Departments, the Carnegie Trust and other bodies, with a view to securing a direct grant from the Treasury, and any other assistance which offers means of realizing the early fulfilment of our programme.

In some respects, the Council for the Promotion of Field Studies will perform for the culture of the countryside what the Council for the Encouragement of Music and the Arts has been doing for the presentation of music and the arts to the community. Not only will it introduce the serious first-hand study of the countryside to a new and to a much wider public, but so "the Council will," in the words of Prof F. T. Lewis of Cambridge, "fill a very important gap in our system of education, both at the school and university level." Its functions are concerned with processes and not merely with the products of intellectual achievement. It will play a vital part in many branches of research. Its financial needs are therefore no less great than those of C.E.M.A., and worthy of at least equal consideration for a direct Treasury grant.

The field centres will be staffed and equipped to provide adequate board, lodging and working facilities for numbers ranging up to forty or fifty students. They must cater for a wide variety of needs and interests—for every science and art the natural province of which is (or ought to be) the open air. They must be able to provide ample and varied material for study, attractive and comfortable but not extravagant living accommodation, the right tools and books and elbow-room during working hours, congenial and useful occupation in spare time. In function, they may be fairly described as residential university outposts in the field, for they would be field extensions of the departments of botany, zoology, geography, geology and archaeology, all of essential use to students of history, dialect, place-names, folk-lore, anthropology, antiquities, art, agriculture, forestry, architecture, town and country

planning, rural crafts, economics, sociology, and so forth. As it gradually becomes fully equipped, a field centre must combine adequate facilities for field work with some at least of the social amenities of a residential college. A field centre would, in short, offer its students something far more tangible, more lasting, than the limited experience of the 'day-excursion' or of the 'bench-experiment' kind.

Each centre will be under the direction of a trained warden. Although it is intended that classes of school and university pupils shall be accompanied by their own teachers, it is essential that the wardens of the field centres should be experienced naturalists and trained field-workers with wide cultural sympathies; they must be able to undertake specific instruction in the field in their own subject as well as advise on other activities in which an intimate general knowledge of the district will be necessary. The position of warden will be one of peculiar responsibility—he will have to direct, advise and collaborate in every way possible—and obviously on him will depend to a very large extent the success and efficiency of a centre. It is considered, therefore, that the post should carry with it a status comparable to that of a university reader or professor.

As well as the student and professional research worker, the Council is especially anxious to attract and help the amateur—the 'born' naturalist, artist or archaeologist—and hopes that local societies and field clubs will co-operate closely with the work of the centres. At each centre there must be, for the novice, expert help and individual encouragement, for the advanced student, every facility for research—the standard must be high in personnel and equipment. For professional research workers from institutions like Wray Castle and Rothamsted, there must be facilities for obtaining comparative data in fundamental long-term investigations, each centre should be an ecological research station and have places reserved for investigators who wish to stay for long periods.

We have mentioned that the centres could be regarded as field outposts of various departments of a university. An important point is the co-operation which could be instituted at a centre between the work of different departments even of the same university. At present these function independently, but all would gain greatly if combined work were done. For example, biologists and archaeologists would have the advantage of information about the geological formation of the area, for the maps and surveys of the geographers would be of service to them, while both geologists and geographers would benefit from first-hand information concerning the fauna and flora. Geologists could receive instruction from geographers in the methods of trigonometrical survey and tachymetry. Also, meteorological data and climatic (or micro-climatic) investigations would be fundamental to many studies. Thus students in different subjects would have the great advantage of working together, seeing each other's methods and results and learning, at first-hand, of the unity of knowledge, which is an ideal so difficult to attain within the somewhat water-tight compartments of a university. There would be further and wider advantages both of a social and cultural nature. Members of the staff as well as students of one university would meet those of other universities in their own as well as in other subjects, when staying at the same centre together. Furthermore, the association of art and science, under the informal and fortuitous circumstances in which their practi-

tioners would meet, would at least be interesting and might well be beneficial to both.

For secondary schools, the centres would afford admirable opportunities for individual or group work in many subjects, including natural history, biology, geology, geography, history, art and allied studies. Many school syllabuses in biology—largely dictated by external examinations—are too academic to appeal to the average boy and girl, and are, therefore, not of the real educational value that they should be. Children are interested in studying living plants and animals in their natural environment, and it is coming to be realized among educationists that this aspect of the subject needs to be greatly encouraged, but unfortunately, few teachers—including university graduates in the biological sciences—have the requisite first-hand knowledge and experience of field-work to teach natural history with competence and enthusiasm. In biology (a subject which purports to be the science of living things), it is far easier to teach and examine classes of pupils by anatomizing dead specimens in the laboratory than by observing living organisms in the field, and this may account for the comparative neglect of the study of animals and plants in their natural habitats.

The evacuation scheme, whereby the schools were dispersed from the cities of Britain into the countryside during the War, has shown only too clearly that for many teachers the countryside is a closed book, comparatively few seem to have been able to make use of the excellent opportunities presented to them for first-hand observation and teaching in the field, even when there was no external examination syllabus to tie them down to an unadventurous and monotonous urban class-room routine. Moreover, in schools permanently situated in the country, it is the exception rather than the rule to do any serious work in the field in school hours, in studies (other than gardening) which specially lend themselves to observational work and the testing and illustrating of teaching and text-book authority at first hand. Admittedly, this work requires detailed knowledge and a carefully planned technique, which are at present outside the range of experience of many teachers in the schools, not having been demanded in their university studies or dealt with in their courses of professional training. The centres will be equipped and organized to enable this special knowledge of field-work to be acquired by teachers and pupils in the various subjects, also teachers will be able to learn the technique of handling classes in the field, which undoubtedly requires special training, experience and facilities, if the work is to be efficient and time and energy conserved. In course of time, perhaps, when the centres have become widely established, new influences will be brought to bear on school and university teaching and examining, and then the Council for the Promotion of Field Studies will be "filling the very important gap which exists in our system of education both at the school and university level." It is hoped that the centres will be widely used by teachers and pupils in the schools, and that they will enjoy working out the fresh approach to culture that field-studies will bring them, with new kinds of technique, in places of great natural beauty that should rejoice the hearts of artists and craftsmen, as well as scientific men, geographers and historians.

Finally, the Council for the Promotion of Field Studies is a scientific society, and therefore it is important that the spirit of research should not

be confined to field and laboratory, but should be applied to the planning, organization and equipment of the centres, and indeed, to the general administration of the Council's activities as a whole. While these activities will be in their completeness it is not yet possible to forecast, but from the widespread and eminent support that the Council has already received, it would seem that we are on the fringe of great possibilities of service to those who wish to make a first-hand study of the many branches of knowledge that have their source and inspiration in the field.

THE SEVERN BARRAGE SCHEME

COAL supplies in Great Britain having become deficient in quantity and quality, public attention has been forcibly directed towards alternative sources of power and energy. The most novel and also the largest single source which has attracted public interest is the Severn Barrage. A scheme formulated by Mr A. G. Vaughan-Lee, Sir William Halcrow and Mr S. B. Donkin, published by the Ministry of Fuel and Power*, gives a broad outline of a method of utilizing tidal power in the Severn Estuary, provides an estimate of the amount of power and energy which would be made available, and the cost thereof.

The principle of the scheme is simple. A dam across the Severn enables water to be impounded during rising tides. This water flows through turbines during the succeeding falling tides. Its potential energy is converted to kinetic energy by the turbines and then to electrical energy by alternators directly coupled to these turbines.

The proposed dam is located at the English Stone some two and a half miles downstream from the mouth of the River Wye, a rough locating point on the north bank of the Severn being the village of Snabrook. It is about two miles long, and comprises sections for inlet sluices, navigation locks and turbines. Thirty-two turbines, in two equal groups, would drive thirty-two alternators, each rated at 25 MW at 0.9 power factor. These would be capable of providing a maximum power output of 800 MW. At spring tide, when the power available is greatest, the total output from the alternators would rise to a maximum of 800 MW in two and a half hours, remain at this value for four hours, and then fall to zero in a further period of about one hour. There would thus be two periods of about seven hours during each twenty-four, in which the plant would be able to generate power and energy. The maximum power and the hour at which it is available changes day by day in accordance with the state of the tide. The daily and seasonal changes of the power and energy output are to be balanced by suitable operation of the barrage power in conjunction with the electric grid system of Britain.

The gross energy available at the barrage would be 2,365 million kWh per annum. If the water flow through the turbines were continuous, the energy available per annum would be 7,008 million kWh.

The ratio $\frac{2,365}{7,008}$, that is, 0.47, is important with

* Ministry of Fuel and Power. Report of the Severn Barrage Scheme by A. G. Vaughan-Lee, Sir William Halcrow and S. B. Donkin. 32 (London: H.M. Stationery Office, 1945.) 2s. 6d. net.

considering the relative merits of the barrage scheme and of other sources of energy, such as interconnected thermal power stations, where the maximum output can be maintained continuously if some 15 per cent of spare plant is provided. About one million tons of coal per annum would be saved by using the Severn power. To maintain constant electrical frequency and output, the turbines are to be of the Kaplan type, with variable-pitch propeller-type runners. The magnitude of the project can be gauged by considering the quantity of material to be used and the labour to be expended.

Civil engineering materials, cement, stone, sand and gravel	6,585,000 tons
Steel	89,000 "
Copper	5,000 "

The labour required for manufacturing plant and constructing the barrage would be 86,840 man-years. The report suggests that the constructional time could be eight years, with an average of 10,355 persons in service over that period. The estimated cost of the barrage (1944 basis) is £40.22 million. This is £50 per kW of plant installed. Thermal power stations cost about £30 per kW, but they have a power-delivering ability of about 85 per cent compared with 47 per cent for tidal stations. They can also be sited closer to power-consuming centres, and can be operated to suit the load requirements.

Ordinary hydro-electric stations, such as are scheduled for construction by the North of Scotland Hydro-electric Board, will cost about £53 per kW. Their power availability factor is not precisely known, it should be of the order of 80 per cent, and is certainly far higher than that of a tidal scheme.

Viewed from the conventional economic point of view, the prospects of the Severn Barrage scheme appear to be bleak. It is, nevertheless, possible or even probable that it will become expedient to construct the Severn scheme in the fairly near future. This renders it particularly interesting to consider its aspects from a practical engineering aspect.

No justifiable doubt exists as to the ability of British engineers to construct the barrage, civil engineering works and electrical equipment. Laymen are liable to be apprehensive about possibilities of disaster, or at least crushing expenditure due to erosion downstream, and silting upstream from the barrage. This aspect has, however, been fully justified by an admirable series of experiments made.

Prof. A. H. Gibson on a scale model of the relevant part of the Severn estuary with and without the barrage. A detailed survey of the estuary made by the Admiralty in 1849 had established the contours of the river bed at that time. Prof. Gibson was able to show that he could reproduce on his model the changes which were caused in the undammed Severn by scouring and silting. Similar experiments on the model provided with a barrage enabled Prof. Gibson to indicate, it is believed accurately, what will take place in the Severn over a period of sixty years after the Severn scheme is put into service.

Prof. Gibson's remarkable investigation, in the best tradition of Osborne Reynolds, has made it possible to predict accurately what the total costs of electricity generated at the Severn Barrage will be over a long period of years. The figure for the energy cost given in the report is 0.199d per kWh at the barrage.

There is an unfortunate tendency on the part of the public to hamper development of schemes of the Severn Barrage class because they are deemed

to be 'huge', nevertheless the fact remains that its cost is only the equivalent of some three days of the British expenditure during the War.

In this connexion, it may be useful to direct attention to a water-power scheme at Catrine, Ayrshire, which was put into service in 1837, and which continues to function to this day, as perfectly as it did initially. The Catrine scheme uses the power of the River Ayr. Two overshot water wheels, each 50 ft in diameter, develop 800 h.p. This power is transmitted to a factory by a shaft 200 ft long. The hydro-power fluctuations are evened out by a 200 h.p. beam, which started work in 1847 and which is still in action.

Although the Severn Barrage is about a thousand times as large as the Catrine scheme, considered as a risk to the community it is trifling compared with that faced and overcome more than a hundred years ago by forgotten Ayrshiremen. Those now responsible for electrical development in Great Britain are not lacking in enterprise, and will doubtless set the Severn to work at its appointed time.

SYMBIOTIC NITROGEN FIXATION

By PROF. ARTTURI I. VIRTANEN

Biochemical Institute, Helsinki

SINCE 1940 I have not had the opportunity of reporting to English readers the results of our investigations on symbiotic nitrogen fixation. As an opportunity now offers itself, I will briefly record in the following the chief points of our research during the War.

Oxaloacetic acid, which according to my conception has a central position in the formation of aspartic acid, has been determined in several leguminous plants at different stages of growth and under different lighting conditions, employing a method previously described¹. The oxaloacetic acid content of the plant is highest at noon and in the afternoon, lowest after the night. If the plants are kept for two days in the dark, the oxaloacetic acid disappears. The pea contains before flowering usually about 50 γ oxaloacetic acid per 1 gm, determined at noon, and red clover about 100 γ. At the end of flowering and when growth ceases oxaloacetic acid is no longer detected in plants².

We have been able to isolate bacterial strains of *Rh. leguminosarum* which causes nodulation on peas but do not fix nitrogen at all (in ten experiments, inoculated pea plants contained on the average 7.5 mgm N per plant, uninoculated control plants 7.3 mgm). By using our sterile culture system, we have been able to show that this is a constant property of this bacterial strain. Although the bacteria were allowed to pass through five plant passages they did not become active nitrogen fixers. The experiments with ineffective and very effective bacterial strains have without exception led to the conclusion that all the reports in the literature on the change of an ineffective strain to an effective one and *vice versa* through successive plant passages are erroneous and due to the fact that the experiments have been carried out in open pots. In such conditions there is always a great danger of contamination by foreign strains. Only in a sterile culture system can reliable results be obtained.

In comparing the root nodules of the pea formed by an entirely ineffective strain (H VIII) with those formed by effective strains, the following differences can be noted

(1) In a sufficient concentration of oxygen, the root nodules formed by effective bacterial strains always contain a red pigment, the interior of the nodule being bright red in colour. The red nodules are active nitrogen fixers.

(2) The nodules formed by the ineffective strain H VIII never contain red pigment and do not fix nitrogen.

(3) In oxygen-free conditions even the nodules of effective strains have no red pigment. These nodules do not fix nitrogen.

(4) If the plants are removed for two or three days into the dark the red pigment turns green. The green nodules are no longer able to fix nitrogen, even when the plants are again brought into light.

All the observations show undoubtedly that the red pigment is essentially associated with the nitrogen fixation and is necessary to this phenomenon. Similar evidence has not previously been furnished of the significance of the red pigment in the leguminous root nodules.

The red pigment of the effective root nodules is not a derivative of dioxyphenylalanine, as assumed by Mothes and Pietz³, but a haemoprotein as Kubo⁴ has shown with the red pigment he isolated from the nodules of soya bean. We have noted with the haemoprotein extracted from the effective root nodules of pea the absorption band at 556 m μ . If the solution is vigorously shaken, the oxyhaemoprotein is formed with absorption bands at 575 and 540 m μ . Also the absorption bands of other haemoprotein compounds correspond approximately to the bands given by Kubo. Thus we have been able to confirm his results. Accordingly, the haemoprotein is a haemoglobin which functions as a store and as a carrier of oxygen. Whether this pigment has also other functions specifically connected with the nitrogen fixation is unknown. The combination of haemin-iron with nitrogen or nitrogen compounds is also a possibility.

[Prof. Virtanen was, of course, unaware of the article "Haemoglobin in the Root Nodules of Leguminous Plants" by Prof. D. Keilin and Dr. Y. L. Wang, published in *Nature* of February 24, 1945, p. 227. Editors.]

The change in the colour of pigment from red to green—demonstrated also in the sterile culture system after the plants have ceased to grow—shows that the red pigment undergoes a change as the activity of the nodules comes to an end. It can be assumed that the ring system is thereby broken and possibly products of pseudo-haemoglobin-type of H. Fischer are formed. The properties of the green pigment are being examined more closely. Likewise we are just doing some experiments to find out whether the nitrogen fixation can be accomplished in cultures of free-living legume bacteria to which has been added haemoglobin of root nodules and oxaloacetic acid. As the bacteria apart from the host plant are not able to synthesize haemoglobin, one reason for the inability of the free-living legume bacteria to fix atmospheric nitrogen must lie in the lack of haemoglobin.

In examining the effectiveness of different strains of nodule bacteria, we have given attention also to the immunity which is brought about by the bacteria

first invading the nodule. For this purpose we have also used the sterile culture system. The results have been as follows.

(1) If the seed of the pea is at first infected with the ineffective strain H VIII and, after the appearance of the first nodules, the culture medium is inoculated with an effective strain, this is no longer able to form nodules. The pea ceases therefore to grow when the nitrogen reserve of the seed has been exhausted, and the plant turns yellow. If the experiment is interrupted at this stage, no increase of nitrogen can be noted in the plant. If the withered plant is, however, left unremoved, in many cases—though not always—a few nodules are formed by the effective strains here and there in the roots, and the pea pushes out new shoots which begin to grow. According to this experiment, the immunity seems to weaken as the plant withers.

(2) If the seed of the pea is simultaneously inoculated with an effective and an ineffective strain, nodules are formed almost regularly by both strains in the roots. The growth of the plant varies accordingly. The pea may grow as well as after inoculation with an effective strain only, but it may also grow very poorly, depending on which one of the strains becomes dominant. Results between these two extremes are perhaps the most common ones.

The immunity is a somewhat local phenomenon. The pea can be grown in a sterile culture system where the roots by means of a branched tube have entered two separate culture flasks, if then the roots in one flask are infected with an ineffective strain and, after the first nodules have appeared there, the uninoculated roots in the other flask are inoculated with an effective strain, the latter is often, though not always, able to form nodules and the pea begins to grow. If the roots are in the same flask, an effective strain used for later inoculation is never able to form nodules before the withering of the plant, as was already mentioned above.

In microscopic examination of the effective and ineffective nodules the following can be noted: the effective red nodules, round cell formations—no rods—are to be seen. The nodules formed by the ineffective strain H VIII contain, on the contrary, rod-shaped bacteria which seem to be surrounded by a slimy layer. In water, under anaerobic conditions the root nodules formed by effective strains contain rods and branched bacteroid forms. On the basis of these observations and with regard to the peculiar fact that a given strain which forms ineffective colourless nodules on one legume may, in another form effective red nodules (cf. our observations on the effectiveness of a bacterial strain on *Trifolium alexandrinum* and on its ineffectiveness on *Trifolium pratense*)⁵ I have formulated the hypothesis that the cause of the inability of an ineffective strain to fix nitrogen in root nodules is perhaps primarily the slimy layer surrounding the bacteria. It prevents the uptake of oxygen, and at the same time the formation of haemoglobin is inhibited. To what extent this hypothesis agrees with the results to be gained will be seen later.

I am indebted to the Rockefeller Foundation for a grant made at the beginning of the War.

¹ Virtanen and Arhmo, *Nature*, **144**, 36 (1939).

² Virtanen, Arhmo, Sundman and Jännes, *J. prakt. Chem.*, **11** (1945).

³ *Naturwiss.*, **25**, 201 (1937).

⁴ *Acta Phytochem.*, **11**, 195 (1939).

⁵ Virtanen, "Cattle-Fodder and Human Nutrition" (Cambridge, 1945).

OBITUARIES

Mr. James Young

MR JAMES YOUNG, lecturer in physics at the University of Birmingham, who died on May 28, 1945, aged forty-seven, was born at Dalferf, Lanarkshire. He was educated at Allan Glen's School, Glasgow, and in 1916 proceeded to the Royal College of Science, South Kensington. After a brilliant academic career, Young joined the physics staff at Birmingham in 1920 and worked with one of his former teachers, Prof S W J Smith.

At South Kensington, under the influence of the late Prof A Fowler, Young's interest in astronomy—an interest dating from early boyhood—was enhanced to such a degree that finally it exercised a dominating influence on his professional life. At Birmingham, he was given charge of the University observatory and the teaching of astronomy. Between the two Wars he devoted himself untiringly to the study of the moon, observing a great many occultations and also examining the lunar craters in great detail. These craters specially attracted him, and from his own observations and from results obtained from other sources, he compiled an exhaustive catalogue of positions and diameters. These data he analysed statistically in order to determine the relation between the diameter and frequency of occurrence. This examination convinced him that the meteoric hypothesis of crater formation was untenable.

In addition to his contributions to astronomy, Young did a great deal of work in collaboration with Prof Smith on the crystallographic analysis of the meteoric irons. Because of their well-developed structure, these natural iron-nickel alloys lend themselves well to X-ray and microscopic examination and are peculiarly adapted to the study of one of the most fundamental questions of ferrous metallurgy, namely, the precise crystallographic mechanism of the $\gamma \rightarrow \alpha$ transformation and its relation to the Widmanstätten structure. The matter is one of some complexity but Young's geometrical insight enabled him to solve the problem almost completely. He also played a part in proving that the Neumann

bands, so characteristic of many meteoric irons, are mechanical twins in the kamacite. Young left much unpublished work in this field. In particular, he examined in detail the crystallographic relations between the kamacite and the imbedded rods of rhabdite.

Despite all these activities, Young never lost sight of the fact that he was a teacher. His simple, direct style was much appreciated by elementary students although, perhaps, he himself preferred more advanced work, especially in subjects with a mathematical bias, such as relativity.

As a man, Young was somewhat aloof and silent, but to those who knew him sufficiently well, he was both charming and helpful. Whenever he intervened in any scientific discussion, his accurate knowledge usually gave him the final word. His last illness was borne with the greatest fortitude, and he continued working in his quiet way until very near the end. We admired him above all for his lasting devotion to astronomy, and those of us who knew him well will often think of him as we pass the Observatory on our way up the hill to the University. He leaves a widow and two daughters. A A DEE

WE regret to announce the following deaths

Mr. C. S. Middlemiss, C I E, F R S, superintendent of the Geological Survey of India during 1895-1917, on June 11, aged eighty-five.

The Right Hon. Lord Onslow, G B E, president during 1936-44 of the Zoological Society of London, on June 9, aged sixty-eight.

Major Charles E S Phillips, O B E, from 1929 until this year secretary of the Royal Institution, on June 17.

Mr A. E. Rambaut, formerly of the Colonial Forest Service, Malaya, on June 2.

Miss E. R. Saunders, formerly fellow of Newnham College, Cambridge, on June 6, aged eighty.

Brigadier-General Sir Percy Sykes, K C I E, C B, C M G, well known for his contributions to the geography and knowledge of Persia, on June 11, aged seventy-eight.

NEWS and VIEWS

The King's Birthday Honours List

The following names of scientific men and others associated with scientific work appear in the King's Birthday Honours List.

G C M G: Sir Frank Stockdale, development adviser to the Secretary of State for the Colonies, late comptroller of development and welfare, West Indies.

K B E: The Hon. Sir Herbert Angus Parsons, senior puisne judge, Supreme Court, and vice-chancellor of the University of Adelaide.

Knights: Mr R. G. Allan, commissioner of agriculture, Baroda State; Dr H. H. E. Craster, Bodley's librarian; Prof C. E. Inglis, lately professor of mechanical sciences in the University of Cambridge; Mr W. J. Jenkins, director of agriculture, Bombay.

C M G: Prof A. V. Bernard, late chief Government medical officer, Malta; Mr L. Nicholls, director of the Bacteriological Institute, Ceylon; Dr B. S. Platt, director of the Human Nutrition Research Unit, Medical Research Council.

C I E: Mr J. C. M. Gardner, forest entomologist, Forest Research Institute, Dehra Dun; Lieut.-Colonel Kombar Ramaswami Krishnaswami Iyengar, director, Pasteur Institute of Southern India, Coonoor; Capt (E) W. J. Liffon, chief surveyor, India.

C B E: Mr F. M. Birks, chief engineer, Gas Light and Coke Co.; Capt F. Burnett, commissioner of lands, Jamaica; Colonel H. W. R. Chandler, director of supplies, Gold Coast; Mr S. O. Chivers, honorary technical adviser to the Ministry of Food on fruit and vegetable products; Mr B. Hart, consultant adviser in psychiatry, Ministry of Health; Dr J. W. McDavid, managing delegate director, Explosives Division, ICI (Explosives), Ltd; Mr W. D. MacGregor, conservator of forests, Sierra Leone; Mr D. M. Matheson, secretary of the National Trust; Mr H. C. Smith, chief conservator of forests, Burma; Mr B. R. Wood, conservator of forests, British Guiana.

Prof. Szent-Gyorgyi

PROF SZENT-GYORGYI, the well-known Hungarian biochemist and Nobel prize-winner, has recently visited Moscow at the invitation of the Soviet Government. On May 17, he lectured to the Physiological Society at the University of Moscow on his new work on the chemical composition of striated muscle (*Acta Physiol Scand*, 9, Suppl 25, 1945). From muscle material Szent-Gyorgyi has succeeded in preparing myosin in a crystalline form, and a new protein, isolated by his collaborator, F. B. Straub, called actin. Both myosin and actin have striking properties. Myosin is completely discharged by minimal quantities of potassium. Actin can exist in both globular and fibrous forms, and in the cycle of contraction both forms are involved. The contractile system consists of a combination of these two proteins actomyosin. In relaxed muscle actomyosin is dissociated into actin and myosin. Actomyosin passes into the contracted form in the presence of potassium, magnesium and adenosin triphosphate. Szent-Gyorgyi has demonstrated the contractile properties of this system *in vitro*, and his work provides a mechanical picture which is consistent with all the phenomena of muscle contraction. It is only necessary to assume that in striated muscle there are double rods of actin and myosin, to account for the contraction of living muscle. If the molecules of myosin are spirally arranged around a chain of actin molecules, then contraction, when myosin is discharged by ions, will result in a sudden decrease in the pitch of the spiral. This theory is consistent with microscopic evidence. The familiar cross-striation can be explained by the optical properties of the spiral. For, by rotating muscle fibre under the microscope, Szent-Gyorgyi has observed the apparent travelling of the spiral along the length of the muscle. This work was done by Szent-Gyorgyi in Szeged between 1939 and 1944. When the Germans occupied Hungary in 1944, Szent-Gyorgyi had to go into hiding, and he took a lead in anti-Fascist activities and preparations for the liberation of Hungary. In February 1945 he was liberated by the Red Army. He has now transferred his laboratory to Budapest, and he has accepted chairmanship of the Hungarian Board of Education. Outside his field of research, Szent-Gyorgyi's main interests are the re-education of his nation for peace, and the re-establishment of international scientific relations.

Prof. Ragnar Granit

ON June 29, Prof. Ragnar Granit is to deliver at the Royal Institution the fourteenth Thomas Young Oration of the Physical Society, and his subject will be "The Electro-physiological Analysis of the Fundamental Problem of Colour Reception." The occasion will provide an opportunity for a first-hand account of Prof. Granit's recent studies of the electrical response of the retina, summaries of which appeared in *Nature* of January 2, 1943, p. 11, and June 16, 1945, p. 711. Some fifteen years ago, Prof. Granit was working at the Johnson Foundation of Medical Physics, University of Pennsylvania, on the general problem of the retina as a nervous centre, in these experiments he relied mainly on the subjective observations of flicker phenomena. Later, he worked in Sir Charles Sherrington's laboratory at Oxford, where he investigated and analysed the retinal action potentials which develop on stimulation of the retina by light, in this work his tests were carried out on

the retinae of decerebrated cats. Since then he has held the chair of physiology at the University of Helsinki and is now at the Nobel Institute of Neurophysiology, Karolinska Institutet, Stockholm. The continued refinement of his experimental technique has enabled him to record the responses from individual receptors in the retina and to investigate their variation with wave-length. This work is of fundamental importance to the understanding of the processes of colour perception. The account of Granit's methods is of interest not only in connexion with vision but also in the much wider field of nerve physiology, indeed his studies of the retina now form only a part of his research activities.

Manchester Joint Research Council

THE Manchester Joint Research Council, which is representative of the University of Manchester and the Manchester Chamber of Commerce, has appointed Mr. A. D. Butchart to be executive officer. Mr. Butchart will commence his duties immediately and will be known as Executive Liaison Officer. As the permanent official of the Council, his duties will cover a wide field, in particular, he will be accessible for discussion and will deal with correspondence having specific reference to any problems facing industrialists where scientific information would prove valuable. It will be recalled that one of the objects of the Council is "the encouragement of activities designed to bring science and industry into closer relationship." As a practical move to give effect to this, the Council is creating an Information Service, and Mr. Butchart will be in charge of it. The service will not aim at furnishing scientific answers to problems submitted, but at placing the inquirer in touch with that scientific institution or authority best able to deal with each particular subject. In short, the essence of the service will be to introduce the industrial inquirer to the relevant scientific worker. Mr. Butchart has had a long experience in the oil industry. As a research chemist and in other capacities he has served in Burma, Iran and Iraq. From the outbreak of war to the present time, he has been employed on important Government work. Until a permanent office can be established, contact can be made with the Executive Liaison Officer, c/o The Manchester Joint Research Council, at the Manchester Chamber of Commerce, Ship Canal House, King Street, Manchester, 2.

Scholarships and Research Fellowships in the Textile Industries

TEXTILE MACHINERY MAKERS, LTD., the constituent firms of which are Platt Brothers and Co., Ltd., Howard and Bullough, Ltd., and other textile machinery manufacturers, have established a scheme for the furtherance of higher education and research in relation to the textile industries. It provides for the first instance for the expenditure of £35,000 over a period of seven years, the administration of the funds being vested in a Board of Trustees for the award of scholarships and research fellowships to be known as "The Sir Walter Preston Scholarships and Research Fellowships" and tenable in the Faculty of Technology of the University of Manchester, or in such other university institution as may be from time to time determined.

The scholarship awards will be as follows: Group for works apprentices who have obtained the High National Certificate in Mechanical Engineering (£250

300 a year for three years), Group II, for works apprentices who have obtained the Ordinary National Certificate in a textile or equivalent subject (£225-300 a year for four years), and Group III for secondary school leavers possessing the Higher School Certificate or equivalent qualification (£200-250 a year for three years). The courses to be followed will be in textile engineering, or mechanical engineering, or textile technology, or economics. A small number of scholarships (Group IV, £300-350 a year for three years) will also be offered to honours graduates in science or engineering in order to attract suitable workers into the textile machinery industry or the textile industry. The Trustees are also empowered to award one or more research fellowships which will enable a selected candidate from any of the groups I to IV to continue in advanced study and research for a further period of two, three or four years, with grants of £400-550 a year.

During the first year of the scheme the following awards will be offered: five in Group I, three in Group II, two in Group III, one in Group IV. In succeeding years further awards will be offered of which due notice will be given. In deciding on the scale of assistance to be given under the scheme, the directors of Textile Machinery Makers, Ltd, have been guided by two main considerations: (1) compensation for the sacrifice of freedom to engage in remunerative occupation, and (2) the desirability of enabling all scholars to play a full part in the social, athletic and other extra-curricular activities of university life. All undergraduate scholars will be required to live in one of the university halls of residence, provided there is accommodation available. The award of scholarships in Groups I and II is restricted to candidates nominated by the constituent companies of Textile Machinery Makers, Ltd. The scheme will come into operation for the university session commencing October 1945, and applications addressed to S H L Greaves, Textile Machinery Makers, Ltd, 60 Huddersfield Road, Oldham, were to be submitted not later than June 23, 1945.

National Certificates in Applied Physics

THE announcement by the Ministry of Education of a scheme for the award of Ordinary and Higher National Certificates in Applied Physics brings to fruition one of the recommendations made in the Institute of Physics report on Education and Training issued in 1943. Students may obtain further particulars of the courses from their local technical colleges or local director of education. With a rapid growth of physics in industry and in the different Government services, it has been found that the existing courses in branches of engineering, in chemistry and so on do not singly provide the combination of knowledge required by juniors in some branches of work which depend on the advances of science, such as, for example, the physical testing of materials and the maintenance and use of instruments for the measurement and control of different processes.

The three-year part-time course for the Ordinary National Certificate in Applied Physics must include mathematics, physics and chemistry, and in the first year a special course (not the orthodox engineering one) in workshop practice and drawing. The physics in the course is to be treated realistically and the principles are whenever possible to be illustrated by practical examples drawn from the industries in which the

students are working. The course in applied physics in the final year is to be related to the local industries. Although English is not included formally as a subject in the course, it is a part of the scheme that at all stages and in all classes attention is to be paid to its correct use. It is hoped in this way to help to train students to present written statements which are clear and concise, when in the course of their employment they are required to report on their work. The course for the Higher National Certificate must be a two-year part-time one, and must aim at reaching a standard in the several branches of physics corresponding to that required for a degree in the subject at pass standard. It will include mathematics and a special subject related to the student's daily work in local industry.

Royal Asiatic Society of Bengal

At the annual meeting of the Royal Asiatic Society of Bengal, the following medals and prize were awarded: Joy Gobind Law Memorial Medal, to Rai Bahadur Dr S L Hora, director of fisheries, Bengal, in recognition of his conspicuously important contributions to our knowledge of the ichthyology of Asia; Paul Johannes Bruhl Memorial Medal, to Dr N L Bor, formerly forest botanist, Imperial Forest Research Institute, Dehra Dun, for his important original research in the Gramineae and the ecology of Indian plants; Dr Bimala Churn Law Gold Medal, to Dr D R Bhandarkar, formerly Carmichael professor of ancient Indian history and culture, University of Calcutta, for his important contributions to ancient Indian history and archaeology; Sarat Chandra Roy Memorial Medal, to Dr Verrier Elwin, of the Bhumijana Seva Mandel, Patangarh, C P, for his meritorious and many-sided contributions to the study of cultural anthropology of India; Elliott Prize for Scientific Research for 1944, to Dr S K Chakrabarty, of the University College of Science and Technology, Calcutta (the Prize for 1944 was for mathematics).

The following officers were elected: *President*, Dr Meghnad Saha, *General Secretary*, Dr Kalidas Nag, *Treasurer*, K P Khaitan, *Philological Secretary*, Dr Nalinaksha Dutt, *Joint Philological Secretary*, Dr Mohammad Ishaque, *Natural History Secretaries*, Dr S L Hora (Biology), Dr K N Bagchi (Physical Science), *Anthropological Secretary*, Rev W G Griffiths, *Historical and Archaeological Secretary*, Dr B C Law, *Medical Secretary*, Dr Indubhusan Basu, *Library Secretary*, Dr Nalinaksha Dutt.

International Commission on Zoological Nomenclature

THE International Commission on Zoological Nomenclature announces its intention of publishing at an early date a revised and up-to-date edition (1) of the "International Code of Zoological Nomenclature" and (2) of the "Official List of Generic Names in Zoology". The last edition of the English text of "The International Code of Zoological Nomenclature" was published some years before the War and is now out of date for various reasons, including the adoption by the International Congress of Zoology of changes in some of the Articles in the International Code. The revised edition will consist of the substantive French text (on left-hand pages) and the English translation (on right-hand pages). The volume, which will be fully indexed, will also

contain a detailed analysis of all the "Opinions" so far rendered by the International Commission in regard to the interpretation of the provisions of the Code "The Official List of Generic Names in Zoology" was established by the International Congress of Zoology at its meeting at Monaco, in 1913 for the purpose of recording full particulars relating to the names of the 5,000-10,000 best-known and most important genera in the animal kingdom with their type species. So far, however, only about seven hundred names have been placed on the "Official List", due largely to the fact that the decisions taken by the International Commission have never hitherto been brought together in a single volume and with a full index. It is hoped that the "Official List" will now develop into a powerful instrument for stabilizing zoological nomenclature. It is hoped that its publication in book form will stimulate specialists to make proposals for the addition of other generic names important not only in systematic zoology but also in the applied sciences and in the teaching of zoology at the universities.

The International Commission is anxious to issue each of the above works at the lowest possible price, for it desires that both shall be within the financial means of every zoologist. This will only be possible if, before publication, the Commission is assured of a sufficient volume of immediate sales. Zoologists are accordingly invited at once to register themselves as prospective subscribers. As soon as the publication price has been fixed, a notification will be sent to all such subscribers, who will be granted a discount of 20 per cent on the publication price, provided that payment at the reduced rate is made to the Commission before the date of publication. All inquiries should be addressed to the International Commission on Zoological Nomenclature at its Publications Office, 41 Queen's Gate, London, S W 7.

Globe Lighting

WHAT appears to have been a clear example of globe lightning has been described by Mr B E Waye, "Larch Gates", Altwood Bailey, Maidenhead, Berks. He writes, "At about 2.20 a.m. on May 8, during the height of an intense thunderstorm, I observed a roughly circular orange glow, about the same apparent diameter as the sun, on the horizon, in a southerly direction. The glow was moving towards the west and was followed by a horizontal column of white vapour. It took about ten seconds to reach a point in the south-west, when it disappeared with a flash, the succeeding noise could not be distinguished with certainty from other claps of thunder."

Lady Tata Memorial Trust

THE trustees of the Lady Tata Memorial Fund announce that, on the recommendation of their Scientific Advisory Committee, they have made the following awards for research in blood diseases, with special reference to leukaemia, for the academic year beginning on October 1, 1945. *Grants for research expenses*. Dr P A Gorer (London) and Dr A H T. Robb-Smith (Oxford). *Personal grant*. Dr Penelope K Hammick (Oxford). *Part-time personal grant and grant for research expenses*. Dr W Jacobson (Cambridge). Since these awards do not fully use the margin of funds available, it is hoped to issue a public advertisement for new candidates from the continent of Europe and elsewhere, as soon as conditions permit.

Summer Schools in Health Education

THE Central Council for Health Education will conduct two summer schools in England this year. One will be residential, during August 4-13, at Kingsmoor School, Glossop, Derbyshire, the other will be non-residential, during August 15-29, at Chelsea Polytechnic, Manresa Road, Chelsea, London, S W 3. The Glossop school will be directed by Mrs F A Ogden, and the London school by Mr L J F Brimble. The schools are intended primarily for those who have to do with the training and care of children and young people—teachers, youth leaders, health visitors, school nurses, educational and medical administrators—but would also be of interest to general practitioners. The object of the schools is to review the principles of mental and physical health and development, to discuss the main health problems confronting the individual and the community, and to consider the methods of health education, including sex education. Those wishing to book accommodation or to be supplied with further details about the schools should write to the Medical Adviser and Secretary, Central Council for Health Education, Tavistock House, Tavistock Square, London, W C 1. The Scottish Council for Health Education is holding a residential summer school at the University of St Andrews during August 18-September 1. The directors of the school are Prof Andrew F Skinner of the University of St. Andrews, and Prof A D Peacock, of University College, Dundee. Courses and lectures will be given under the headings of physiology, psychology and social medicine. Further information concerning the Scottish school can be obtained from the Secretary and Treasurer, Scottish Council for Health Education, 3 Castle Street, Edinburgh, 2.

Announcements

UNDER the statute of the Royal Society which provides for the election of persons who either have rendered conspicuous service to the cause of science or are such that their election would be of signal benefit to the Society, the Right Hon. Sir John Anderson, Chancellor of the Exchequer, has been elected a fellow of the Society.

DURING his recent tour in Sweden to lecture on penicillin, under the auspices of the British Council, and at the invitation of the Swedish Medical Society, Sir Howard Florey, professor of pathology in the University of Oxford, was presented with the Berzelius Medal in silver. This Medal was given to members of the Swedish royal family and certain other distinguished persons when it was instituted in 1850 but has not been awarded since that time.

SIR D'ARCY THOMPSON, professor of natural history in the University of St Andrews, has been awarded the Daniel Giraud Elliot Medal for 1942 by the U.S. National Academy of Sciences. The Medal is awarded for distinguished work in some branch of zoology or palaeontology.

A CONFERENCE on "School and Society" will be held under the auspices of the Institute of Sociology at St Hilda's College, Oxford, during July 26-August 3. The president of the conference will be Sir David Ross, whose presidential address is "The Challenge: the Present Crisis and the Needs of the Revolution". Further information concerning the conference can be obtained from the Hon. Organizing Institute of Sociology, Le Play House, Albert Road, South, Great Malvern, Worcestershire.

LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications.

Cancelled Visit of British Men of Science to the Academy of Sciences of the U.S.S.R.

MANY readers of *Nature* will have been astonished and repelled by the studied discourtesy with which eight of the intending guests of the Soviet Academy of Sciences were prevented by His Majesty's Government last week from going to Moscow. Not only were they put to gross inconvenience and annoyance by the refusal, without warning and at the last moment, of permission to travel, but also the explanation given was as incredible as the real reason was insulting.

In this prohibited group were those whose talents and devotion have rendered priceless service to the nation during the War. But let us remember the words of the "Preacher"

"There was a little city and few men within it, and there came a great king against it and besieged it and built great bulwarks against it

"Now there was found in it a poor wise man and he by his wisdom delivered the city yet no man remembered that same poor man

"Then said I, Wisdom is better than strength nevertheless the poor man's wisdom is despised, and his words are not heard"

The offensive treatment of our scientific colleagues, unconceivable towards members of most other professions, is a sufficient comment on the patronizing ministerial praise with which science and scientific men are occasionally favoured. When they, and others, are offered reparation later on 'awards' or honours, let them recall the words of T. H. Huxley

"The sole order of nobility which, in my judgment, becomes a philosopher, is the rank which he holds in the estimation of his fellow-workers, who are the only competent judges in such matters"

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Distribution of Vanadium, Chromium, Cobalt and Nickel in Eruptive Rocks

WHEN analysing the rock differentiation suite of the Skaergaard intrusion, Greenland, L. R. Wager and R. L. Mitchell¹ found a most interesting distribution of the above trace elements, which are comparatively immobile

TABLE 1 THE SKAERGAARD INTRUSION (EARLY ROCKS MENTIONED FIRST, - THE CONCENTRATIONS CALCULATED AS WEIGHT PER CENT, SPECTRUM ANALYSIS)

	Gabbro-picroite	Olivine-gabbro	Middle gabbro	Horton-olite-ferrogabbro	Late basites, $M(n=3)^*$	Acid granophyre
V	0.010	0.020	0.026	0.004	0-tr	0.0010
Cr	0.115	0.023	0-tr	0-tr	0-tr	0.0003
Co	0.008	0.007	0.004	0.006	0.0020	0.0003
Ni	0.06	0.020	0.0025	0-tr	0.0001†	0.0005

* Includes a basic granophyre

† Two members have given 0-tr

Independently, I determined the content of several trace elements on intrusive rocks from Eastern Upland, Sweden. The following concentrations were obtained (for explanations, see Table 1)

TABLE 2 NORMAL DIFFERENTIATION SUITE, EASTERN UPLAND

	Pyroxenite-hornblende	Basic quartz-gabbro	Diorite	Late Diorite	Granite, $M(n=2)$
V	0.033	0.05	0.025	0.0025	0.0040
Cr	0.015	0.0085	0.0005	0	0.00040
Co	0.0040	0.0040	0.0048	0.0025	0.0011
Ni	0.012	0.009	0.0075	0	0.0010

TABLE 3 LATE, ABNORMAL DIFFERENTIATION SUITE, EASTERN UPLAND

	Peridotite	Allivalite	Ultra-basic norite	Amphibole-gabbro	Microcline-granite (tr.)
V	0.006	0.0015	0.10	0.035	0.0010
Cr	0.0005	0.00013	0.00020	0	0.00010
Co	0.020	0.006	0.0005	0.0023	0.00005
Ni	0.045	0.012	0.0020	<0.00002	0.00005

Comparing Tables 1-3, it might be assumed that the amounts of Fe + Mg are to be regarded as similar in each member, according to the analyses. We may here point out the striking resemblance between Table 1 and Table 2, whereas the rocks of Table 3 in part display a different behaviour of the actual elements. The problem will be dealt with more fully in a later paper.

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¹ *Min. Mag.*, 28, 286 (1944)

Intensities of Light Absorption

It is an interesting and well-known fact that the order of magnitude of the highest extinction coefficients recorded for the absorption of light rarely exceeds $\epsilon \sim 10^5$, where ϵ is the molecular extinction coefficient.

The problem of absorption intensity can be approached in a simple way, as follows. Consider light of intensity I falling on a slice of thickness dl of a cell of unit area filled with the vapour or a dilute solution in a transparent solvent of the absorbent at a concentration of c gm-mol per litre. Let the average effective absorbing area ('chromophore area') of the absorbing molecules in the plane perpendicular to the incident light be a . Then

Illumination falling on absorbing molecules

$$= \frac{\text{Area of absorbing molecules}}{\text{Total area}} \times \text{Total illumination} \\ = \frac{cNadl}{1000} I,$$

and

$$\text{Illumination absorbed} = -dI = F \frac{cNadl}{1000} I,$$

where F will be termed the *light extinction factor* and represents the fraction of the light falling on the absorbing molecules which is absorbed, and N is the Avogadro number. Integrating between the limits $l=0$ and $l=l$

$$\epsilon = \frac{1}{cl} \log_{10} \frac{I_0}{I} = \frac{FNa}{2.3 \times 1000} = 2.64 \times 10^{-20} Fa \quad (1)$$

If a is taken as the largest cross-sectional area ($[a]$) of the molecule and F put equal to unity, (1) yields the maximum possible value ($[\epsilon]$) of ϵ for that molecule. For a simple molecule, $[a]$ is of the order of 10^{-16} cm², hence $[\epsilon] \sim 10^5$.

Both classical electromagnetic theory and quantum mechanics lead to the expression

$$f = \frac{23 \times 10^3 \times mc^2}{N\pi e^2} \int \epsilon_r d\nu \quad (2)$$

for f , the effective number of oscillating electrons or 'mean oscillator strength', where m and e are the mass and charge of the electron, c the velocity of light, N the Avogadro number, ϵ the molecular extinction coefficient and ν the wave number. For an absorption band of normal half-width (c 2,000 cm^{-1}) in the visible and ultra-violet region, $f = 1$ requires^{1,2,3} $\epsilon \sim 10^6$.

The simple treatment outlined above thus yields the same result for the maximum possible value of ϵ as the classical one, but F , unlike f , is an absolute quantity which depends only on molecular size and configuration and involves no assumption as to the mechanism of absorption. The observed values of ϵ_{max} are always smaller than $[\epsilon]$, this can be due to

(1) a being smaller than $[a]$ if, as will generally be the case, the system responsible for absorption in the wave-length region considered does not comprise all the atoms of the molecule, or if, in an optically anisotropic molecule, absorption depends on the spatial orientation of the molecule with respect to the incident light

(2) F being smaller than unity, if the transition does not always occur when a photon of the right magnitude falls on the molecule in the optimum spatial orientation. In classical and in quantum theory, the interaction probability depends on the dipole moment ('transition moment') associated with the transition, but F will also be reduced if only certain electronic, vibrational or rotational states of the molecule represent absorbing entities, or, in a different terminology, if the transition only occurs in certain resonance forms of the molecule. The magnitude of F may be regarded as a measure of the contribution which the resonance form responsible for absorption in the wave-length region considered makes to the 'hybrid' ground state

On the other hand, if F is assumed to be unity or can be otherwise estimated, the effective chromophore area (a) can be calculated from the observed value of ϵ_{max} . In a spherically non-symmetrical molecule the calculated value of a will be smaller than the true chromophore area by a statistical factor due to random orientation

In linear polyene systems⁴ of type $-(C=C)_n-X$, $\epsilon_{\text{max}} \propto n$. If F is independent of n , $a \propto \epsilon_{\text{max}}$, hence $a \propto n$. This requires the most effective incident direction for absorption to be perpendicular to the molecular axis and substantiates the view^{5,6} that the electrons responsible for absorption in the visible and ultra-violet regions of the spectrum are directed in a plane perpendicular to that of the covalent bond.

I am indebted to Dr M. Blackman for valuable discussion.

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¹ Forster, *Z. Electrochem.*, **45**, 548 (1939)

² Mulliken, *J. Chem. Phys.*, **7**, 14 et seq. (1939)

³ Spomer and Teller, *Rev. Mod. Phys.*, **13**, 75 (1941)

⁴ Hauser, Kuhn, Smakula and Hofer, *Z. Phys. Chem.*, **B 29**, 371 (1935)

⁵ Pauling, "The Nature of the Chemical Bond" (Cornell, 1940)

⁶ Lennard-Jones, *Proc. Roy. Soc. A*, **158**, 280 (1937)

The Two-body Gravitational Problem in Kinematical Relativity

THE equations of motion of two gravitating particles have been given by Milne¹, they are second-order differential equations in $(t_1, \mathbf{P}_1)$, $(t_2, \mathbf{P}_2)$ the epochs and vector positions of the two particles as measured by a fundamental observer, O. From their derivation, the equations are invariant for Lorentz transformations from one fundamental observer to another. There are eight variables, four for each particle, but only six differential equations—since Milne's equations (45') and (46') may be deduced from (45) and (46). Thus a further relation is needed in order to integrate the equations.

Milne has proposed for this relation the equation $t_1 = t_2$, so that the event $(t_1, \mathbf{P}_1)$ in the history of the particle m_1 , and the event $(t_2, \mathbf{P}_2)$ in the history of m_2 are simultaneous in the experience of O, the relation, as he points out, is not invariant for Lorentz transformations. Schild² has recently suggested that this invalidates the whole treatment, since if the equations are solved with the additional relation $t_1 = t_2$, the orbits obtained will not be invariant.

However, there is no difficulty in finding an invariant relation to replace $t_1 = t_2$, and contrary to Schild's expressed view, there is little or no choice. Since only one relation is needed, it will be symmetric in the suffixes 1 and 2, and it will also be a scalar relation. Only three invariant scalars can be constructed from the two four-vectors, $(t_1, \mathbf{P}_1)$, $(t_2, \mathbf{P}_2)$ namely, $t_1^2 - \mathbf{P}_1^2/c^2$, $t_2^2 - \mathbf{P}_2^2/c^2$, $t_1 t_2 - \mathbf{P}_1 \cdot \mathbf{P}_2/c^2$. There is a further condition that $t_2 \rightarrow t_1$ as $\mathbf{P}_2 \rightarrow \mathbf{P}_1$. The relation suggested by Schild may be written

$$(t_1^2 - \mathbf{P}_1^2/c^2) + (t_2^2 - \mathbf{P}_2^2/c^2) = 2(t_1 t_2 - \mathbf{P}_1 \cdot \mathbf{P}_2/c^2)$$

This is more simply expressed in the form,

$$t_2 - t_1 = \pm |\mathbf{P}_2 - \mathbf{P}_1|/c$$

Taking the upper sign, we see that the effect of n on m_2 is associated with a retarded time, whereas the effect of m_2 on m_1 occurs at an advanced time so that the relation is not truly symmetrical.

The only relation which seems entirely acceptable

$$t_1^2 - \mathbf{P}_1^2/c^2 = t_2^2 - \mathbf{P}_2^2/c^2$$

Putting each side of this equation equal to T^2 , we obtain a simple physical interpretation. The event $(t_1, \mathbf{P}_1)$ is the passing of the particle m_1 and a fundamental observer A_1 , who records the epoch of the event as T , similarly, the event $(t_2, \mathbf{P}_2)$ occurs at a fundamental observer A_2 , in whose experience the epoch is also T . This gives a definition of simultaneity which is invariant, two events are simultaneous in this sense if the epochs assigned to them by the fundamental observers at which they occur are equal.

The actual equations of motion have a remarkable property in that, no matter what relation is assumed between t_1 and t_2 to make the problem determinate they possess an energy integral. Denoting by E_1 , E_2 , the gravitational potential and the kinetic energies of the two particles, Milne has shown that

$$\frac{dE_1}{dt_1} + \frac{\partial \chi}{\partial t_1} + \frac{d\mathbf{P}_1}{dt_1} \cdot \frac{\partial \chi}{\partial \mathbf{P}_1} = 0,$$

with a similar equation for E_2 and t_2 . If t_1 and t_2 are unspecified functions of a single parameter s , the rate of change of total energy with the parameter

$$\frac{E_1}{t_1} \frac{dt_1}{ds} + \left(\frac{\partial \chi}{\partial t_1} + \frac{dP_1}{dt_1} \frac{\partial \chi}{\partial P_1} \right) \frac{dt_1}{ds} + \left(\frac{\partial \chi}{\partial t_2} + \frac{dP_2}{dt_2} \frac{\partial \chi}{\partial P_2} \right) \frac{dt_2}{ds} + \frac{dE_2}{dt_2} \frac{dt_2}{ds}$$

this is zero, independently of the relations between t_1 , t_2 and s . Thus $(E_1 + \chi + E_2)$ is constant for any fundamental observer, no matter what definition of simultaneity he adopts

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March 29

Milne, *Proc Roy Soc. A*, **160**, 12 (1937)
Schild, *Phys Rev*, **66**, 340 (1944)

I AM in general agreement with the content of Mr Camm's letter. The fact which he independently arrives at, that the energy integral in the problem of two bodies (or indeed, of any number of particles) is independent of the simultaneity convention adopted, I had already encountered in my own work. I may point out here that until some simultaneity convention is adopted, a conservation law applying to a number of different particles has no meaning, for the essence of a conservation law is that we pick out some attribute of the motion of each particle, and add them all together. If these attributes are varying in time, as in gravitational problems, it is essential to decide at what epoch to evaluate each attribute, and so to adopt a standard of simultaneity. It is therefore very satisfactory that the conservation of energy comes out independently of the standard of simultaneity adopted. Similar considerations apply to the conservation of linear and angular momentum, to which I hope to return on a future occasion.

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Thermal Stability of D.D.T.

It appears that on certain information obtained from America the belief has become current that D.D.T. decomposes and loses hydrogen chloride at relatively low temperatures, for example, of the order of 107–130°C.

Recently, Fleck and Haller¹ have shown that iron and aluminium compounds catalyse this decomposition very readily at 110–120°C, in 15 minutes to the extent of 99 per cent with the formation of the corresponding dichloroethylene (m.p. 88–89°C). We have now examined the thermal stability of D.D.T., and find that this substance, whether it be pure or of commercial quality, is only decomposed at relatively high temperatures.

We have confirmed Fleck and Haller's observations that metal salts, even in very small amounts, enhance the onset of this decomposition.

Our experiments were carried out by placing samples of D.D.T. in a tube fitted with a thermometer and an air-bubbler, and heating in a glycerine bath. The air was drawn through a short air condenser and passed into 1 per cent silver nitrate solution, acidulated with nitric acid. The sample (c. 40 gm.) was melted at 110–115°C, and the temperature raised at the rate of 1.2–1.4°C/minute. The decomposition point was noted as the temperature at which definite turbidity appeared in the silver nitrate solution.

In sample No. 2, rapid evolution of hydrogen chloride set in with consequent precipitation of silver chloride.

No	D D T sample taken m.p. in °C	Decomposition point (°C)	m.p. of recovered material (°C)
1	Batch 50, 80% p p', m.p. 96–102, setting pt 96	200	98–100
2	As above + 0.1% FeCl ₃	120	81–91
3	As above + 0.005% FeCl ₃	150	94–100
4	MBL/204/2, 71% p p', m.p. 89–100	188	—
5	Batch 203, 75% p p', m.p. 82–94	170	82–92
6	D D T m.p. 108.5–109.5 (corr.), setting pt 107.5	195	106–107.5 (corr.)

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¹ Fleck and Haller, *J. Amer. Chem. Soc.*, **66**, 2095 (1944)

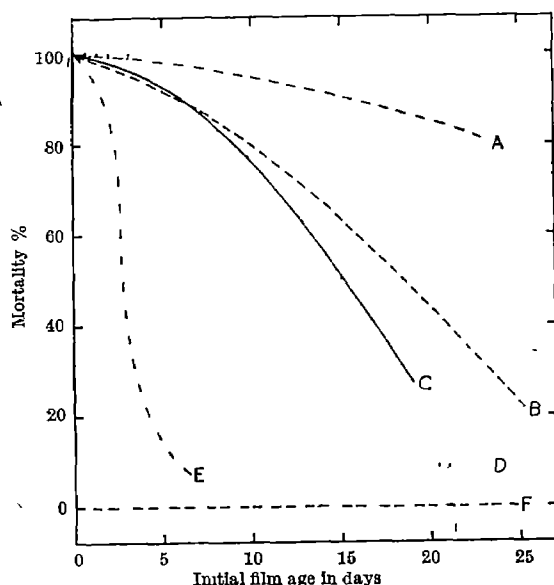
Effect of Pretreatment on the Toxicity of Insecticidal Films on Building Surfaces

INSECTICIDAL films, formed by the deposition of a solution of pyrethrins in a heavy refined mineral oil of very low volatility, for example, Shell Oil P 31, have been used in warehouses for the control of *Ephestia* and *Plodia* moths and caterpillars¹. These films were formed on wooden boxes. There has more recently been a considerable increase in scope for the use of such films for controlling other pests of stored foodstuffs, especially beetles, which are more resistant than the moths and their caterpillars to most insecticides, including the pyrethrins. We have found, however, that, other things being equal, the toxicity of films of pyrethrins in a heavy oil differs widely according to the material upon which the insecticide is deposited.

In laboratory experiments at 25°C and 70 per cent relative humidity, samples of different building materials were sprayed with 1.6 per cent w/v pyrethrins in P 31 oil at a rate of 4 mgm/sq. cm., this deposit is much greater than that applied in practice. Twenty-four hours after spraying, batches of flour beetles, *Tribolium castaneum* Herbst, were confined on the samples. The percentages of insects knocked down and dead after six days exposure to the insecticide are shown in the accompanying table.

Surface	Knock-down (%)	Dead (%)
Rough deal	100	59–77
Brick	100	15–31
Limewashed brick	0–12	0–8
Concrete	0–16	0–16
Cement	0–10	0–10

Thus, oil films incorporating pyrethrins as the toxic agents were of moderate toxicity when deposited on deal, of low toxicity on brick, and virtually non-toxic on limewash, concrete and cement. A trial under practical conditions has confirmed the differ-



THE TOXICITY TO *T. castaneum* OF FILMS FORMED ON PRE-TREATED CEMENT BY 1.5 MG/M² OF 1.6 PER CENT PYRETHRINS IN P 31. INSECTS CONFINED ON FILMS FOR 8 DAYS. PRETREATMENTS: A, SIZE (10 PER CENT), B, GELATIN (5 PER CENT), C, STARCH PASTE, D, POLYVINYL ACETAL EMULSION, E, BRICKWORK SEALING PAINT, F, NO PRETREATMENT.

ence in toxicity between insecticidal films on wood and on limewash.

Ways have been sought to increase the toxicity and persistence of these films. The most striking results were obtained by pretreating the surfaces, before application of the insecticide, with substances which might be expected to reduce greatly the rate of sorption into the substrate, and so to render the insecticide more available to insects walking over the surface. Many substances, including water, hygroscopic materials, sodium silicate preparations, paints, varnishes and colloidal gels were put through preliminary tests to assess their value as pretreatments. The relation between film toxicity and film age was determined for some of the most promising of these when applied to cement. The accompanying graph shows the results. Insecticidal films formed by deposits of 1.5 mgm/sq cm of 1.6 per cent pyrethrins remained highly toxic under laboratory conditions for more than three weeks on some coatings.

After further investigation, size and gelatin, applied in aqueous colloidal solution, have been selected as the most useful of the materials at present available, gelatin was better than size at equal concentration. A solution of pyrethrins was used in most of the laboratory work, but coatings of size or gelatin also supported solutions of other insecticides, including DDT, in an oil base.

A trial of size under practical conditions indicated that it was effective, provided that a continuous coating was formed.

This work forms part of the programme of work of the Pest Infestation Laboratory, and this note is published by permission of the Department of Scientific and Industrial Research.

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¹ Potter, *Ann. Appl. Biol.*, 22, 769 (1935), 25, 836 (1938).

Preliminary Report on the Purification and the Molecular Weight of Hypertensin

DURING an investigation on the chemistry of hypertensin some facts have emerged worth a brief report. Hypertensin has been purified to a very high degree, its effect in raising the blood pressure of a cat under chloralose anaesthesia equalling that of adrenaline. The smallest dose eliciting an appreciable effect on the blood pressure lies in the vicinity of 0.5. Important steps in the ultimate purification are chromatography¹ and electro dialysis.

The former rests upon the fact that hypertensin adsorbed on aluminium oxide from a methyl alcohol solution and eluted with appropriate mixtures of methyl alcohol and water.

For the electro dialysis an apparatus constructed by Hammarsten² was employed. Parchment paper was used as cathodic membrane, and goatskin, which is impermeable to hypertensin, as anodic membrane. It was found that if the reaction in the centre compartment was held more alkaline than pH 7.5 with barium hydroxide, no hypertensin passed into the cathodic compartment. Thanks to this fact, inorganic salts and other impurities could be removed without loss of activity. When thereafter the reaction in the centre compartment was made acid to pH 3 with sulphuric acid, hypertensin rapidly passed out into the cathodic compartment. 1 mgm. of this preparation obtained in good yield (70–80 per cent) had a activity corresponding to 35 mgm. tyramine phosphate. The nitrogen content (Kjeldahl) was 13.6 per cent.

From the last experiment together with earlier electrophoresis experiments³ it was concluded that hypertensin must be neutral or nearly neutral in character. Hence a determination of the diffusion constant at neutral reaction would give information—though approximate—on the molecular weight of hypertensin. The apparatus and technique of Theorell⁴ were used, and the diffusion was followed by activity measurements. To prevent inactivation of hypertensin the experiments were performed at 0°C. In two different determinations the diffusion constant was found to be 1.20×10^{-6} cm²/sec resp. 1.18×10^{-6} cm²/sec. Assuming for hypertensin a specific volume of 0.75, the diffusion constant obtained corresponds to a molecular weight of 2,750.

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¹ Edman, P., *Ark. Kemi, Mineral, Geol.*, B, 18, No. 2 (1944).

² Agren, G., *Diss., Skand. Arch. Physiol.*, 69 (1934).

³ Edman, P., v. Euler, U., Jorpes, E., and Sjöstrand, T. O., *J. Physiol.*, 101, 284 (1942).

⁴ Theorell, H., *Biochem. Z.*, 275, 19 (1934–35).

British and Continental Races of the Starling, *Sturnus vulgaris* L., in Canada

AN account of the differences in timing of the reproductive cycles of the British and Continental races of the European starling has been given by Bullough¹, and the consequent differences in external morphology and in behaviour have been emphasized. It was suggested that these differences, particularly in behaviour, may prevent cross-breeding, and that in any event the two races must be considered as subspecifically distinct.

It was further suggested that a critical test of the separate nature of these races might be obtained from a study of the starling in North America. The species was introduced there on numerous separate occasions before the United States Lacey Act of 1900 prohibited further importations of alien species. It is generally considered, although not proved, that the successful introductions were those of 1890 and 1891 in the Central Park, New York City, and that it was the descendants of these few birds which spread half-way across the continent and north into Canada^{2,3}. From the many descriptions of the habits of these birds in their new home, it was already evident that the Continental race of starling was present in enormous numbers, living a flock life throughout the summer, autumn and winter, and developing the migration habit as in Europe. On the other hand, there was also evidence that the British race was present too. Bissonnette⁴, in Connecticut, discovered starlings with unusually large gonads in winter, and associated with this was the observation of Hicks and Dambach⁵, in Ohio, that there are present in winter many pairs of mated birds which roost, feed and live independently "near cavities where they will nest in the spring". Enlarged gonads in autumn and winter, and a consequent interest in nesting sites, are distinguishing features of the British race of starling.

A study of the starlings present in Ville St. Laurent (near Montreal, Quebec), made during the autumn and winter of 1944-45, has confirmed the presence of both races. In October and November the Continental starling was especially common, ranging the countryside in flocks. These birds had dark beaks, indicating the absence of gonad activity, and associated with this, they were unpaired, uninterested in their old nesting sites, and they roosted communally. In sharp contrast, there were also present smaller numbers of British starlings. These birds had beaks turning yellow at the base, indicating gonad activity, and associated with this they were already paired, and spent much time singing by their old nesting sites. Although they remained all day in the close vicinity of these nesting places, in the evening they joined the Continental starlings in the communal roosts.

Towards the end of autumn, just before the onset of severe weather, the southward migration of the Continental starlings was complete. Consequently, in December and January, relatively few of these birds remained in Ville St. Laurent, and it seemed possible that the few which did so came from even farther north. The majority of the starlings remaining in the neighbourhood were of the British type. By the middle of January, these individuals had beaks almost fully yellow, and their attachment to their nesting sites was further strengthened by the fact that nest-hole roosting in pairs then took the place of communal roosting. The few Continental birds which remained had uniformly dark beaks until the end of January when, in some individuals, the first signs of yellow colour appeared. The birds, however, remained unpaired and continued to roost communally.

When, about the middle of March, the huge flocks of Continental starlings returned to the Montreal district, these birds still had beaks which were partially, or even in a few cases wholly, dark, they were unpaired, and being as yet unattached to nesting sites, they still roosted communally. At this same time, the adult British starlings had fully

yellow beaks, nest-building had begun and copulation was frequently observed.

It is therefore evident that the difference in the reproductive rhythm, which distinguishes these two races of the starling in Europe, has proved sufficiently powerful to preserve their separate identities on the American continent for a period of fifty-five years of the most considerable increase in numbers and the most active spread of the species. All this time the breeding ranges of the two forms have been either identical or have overlapped, a state of affairs which is not apparently found in Europe. However, unless there exists some more positive bar to interbreeding than is provided by the fact that the British starlings pair in early autumn while the Continental starlings do not do so before the late winter and early spring, it seems inconceivable that some mixing of the two races has not occurred. To determine the precise amount would obviously require a large-scale statistical study; but it is already abundantly clear, at least in the neighbourhood of Montreal, that such mixing as may have taken place is inconsiderable.

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April 6.

¹ Bullough, W. S., *Phil. Trans. Roy. Soc.*, B, **231**, 165 (1942).

² Kalmbach, E. R., and Gabrielson, I. N., United States Department of Agriculture, Bulletin No. 868 (1921).

³ Lewis, F. L., University of Toronto Studies, Biological Series, No. 30 (1927).

⁴ Bissonnette, T. H., personal communication (1940).

⁵ Hicks, L. E., and Dambach, C. A., *Cardinal*, **4**, 25 (1935).

X-Ray Induced Mutations in the Physiology of *Ophiostoma*

Tatum's and Beadle's¹ investigations on *Neurospora* inspired me to attempt to induce physiological mutations in *Ophiostoma multiannum* (Hedge. and Davids.) by means of X-ray treatment. Normal strains of this fungus grew optimally on a synthetic medium containing glucose, ammonium tartrate, inorganic salts, aneurin (= vitamin B₁) and pyridoxin (= vitamin B₆)². Out of 775 monosporous mycelia which were obtained from X-ray treated ascospores by means of a special procedure³, 12 (that is, 1.6 per cent) differed physiologically. The manner in which they differed is shown in the accompanying table.

Strain No.	Physiological properties
225	Biotin-heterotrophic.
358	Parathiotrophic: able to reduce 4-valent sulphur.
446	" : unable to reduce 4-valent sulphur.
460	Requires uracil; also growing with uridine, cytidine or cytosylic acid
513	Requires adenine; also growing with adenosine or adenylic acid
617	Requires <i>p</i> -aminobenzoic acid.
620	Requires adenine as No. 513
636	Parathiotrophic as No. 446
692	" " " "
829	" " " "
834	" " " "
848	Requires guanine; also growing with guanosine.

The ability of No. 358 to reduce 4-valent sulphur (sodium sulphite) was not transmitted to the following generations. All the other physiological properties however, shown in the accompanying table were heritable. These strains should, therefore, be considered as physiological mutants. *O. multiannum*

being heterothallic and rapidly giving rise to perithecia, it was possible to produce by means of adequate combinations monosporous mycelia possessing two or more of the reported divergent properties in the next or later generations.

Parathiotrophy which was induced in five strains in the present study has so far been observed in Nature solely in Saprolegniaceae⁴ and in certain bacteria⁵. The parathiotrophic strains investigated which were not able to reduce 6-valent sulphur (as sulphate or sulphone) assimilated two-valent sulphur as, for example, sodium sulphide, cystine, cysteine and $\text{CH}(\text{SCH}_3)_3$.

The three strains which required adenine required rather considerable quantities of this purine. These quantities were at least a thousand times larger than the required amounts of aneurin and pyridoxin. The mycelium/adenine-quotient seemed to be equivalent to approximately 100. The action of guanine (on strain No. 848) has quantitatively not yet been extensively investigated. This applies, too, to the action of uracil on strain No. 460, in which also cytidine and cytosylic acid—though not cytosine—are active. In all these cases the indispensability of a certain nuclein compound to a certain strain seemed to be due to the fact that this strain lost the ability to synthesize the substance in question, which is necessary for the formation of essential nucleoproteids, co-ferments, etc.

The two auxo-heterotrophic mutants which were induced, that is, the biotin-heterotrophic mutant No. 225 and the *p*-amino-benzoic-acid-heterotrophic mutant No. 617, required only exceedingly small quantities of the growth-substances mentioned. Biotin was even active in a dilution of 10^{-12} , and *p*-aminobenzoic acid in a dilution of 10^{-10} .

More detailed reports of these investigations will be published in Swedish journals of botany.

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University of Uppsala.

March 14.

¹ Beadle, G. W., and Tatum, E. L., *Nat. Acad. Sci. Proc.*, **27**, 499 (1941). Tatum, E. L., and Beadle, G. W., *ibid.*, **28**, 234 (1942). (only available in abstracts.)

² Fries, N., *Symb. Bot. Upsal.*, **7**, 2 (1943).

³ Fries, N., *Ark. Bot.*, **32**, 4 (1945).

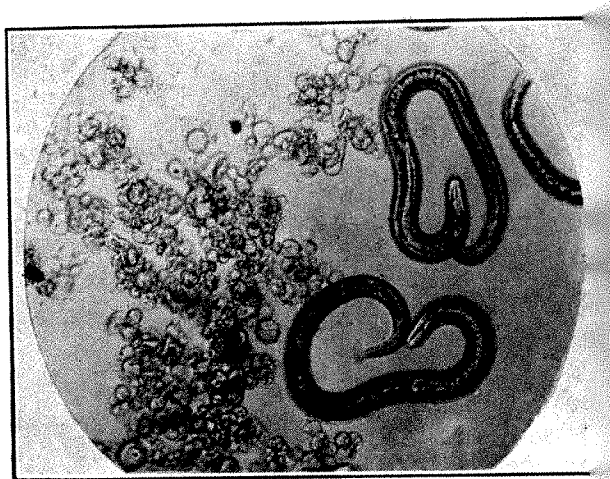
⁴ Volkonsky, M., *C.R. Soc. Biol. Paris*, **109**, 528 (1932).

⁵ Fildes, P., and Richardson, G. M., *Brit. J. Exp. Pathol.*, **18**, 292 (1937).

Serodiagnosis of Trichinosis by Microscopical Testing with Living *Trichina* Larvæ

DURING the last ten to fifteen years, diagnosis of *Trichina* infection in man (and partly also in swine) has been made easier by the adoption of different methods, based on the immunological response of the organism to the parasite. Particularly, the intradermal and the precipitin test with *Trichina* antigen, both first described by Bachman^{1,2}, have been used in many modifications. Thus, I am employing for this purpose a clear Seitz filtrate prepared from *Trichina* larvæ that had been freed from their cysts by artificial digestion, dried, pulverized and then extracted in physiological saline in the ratio 1:100. Though both these tests are a great help in the diagnosis of trichinosis, they may also fail in very mild cases of this disease, and, on the other hand, unspecific reactions may be obtained in persons not suffering from it.

In January 1941³, I proposed a more delicate and more specific microscopical test depending on the peculiarity of living trichina larvæ at 37° C. of evoking typical precipitates in immune serum. Since then, this new method has been tried with good results in some hundred cases of suspected human or animal trichinosis by Hauge⁴ in Norway as well as by me in Denmark and Sweden (*cf.* Bergwall⁵ and Norup⁶). In this connexion it might be mentioned that during recent years several outbreaks of trichinosis have occurred both in Norway and in Sweden, while no cases at all have been reported in Denmark and in Finland.



BUBBLE-LIKE PRECIPITIN REACTION OF IMMUNE SERUM AGAINST LARVÆ OF *Trichinella spiralis*, AFTER 24 HOURS INCUBATION AT 37° C. SERUM SAMPLE FROM PATIENT D.A., 23 DAYS AFTER HIS FALLING ILL. $\times 80$.

For the microscopical test, well-coiled *Trichina* larvæ are needed, which, after having been freed from their cysts by artificial digestion, are very carefully washed with sterile saline. For each test about a hundred larvæ are placed in the depression (diameter 20 mm.) of a sterile, 3.5 mm. thick hollow-ground slide and then covered with 0.5 c.c. of the twice centrifugized serum. A large sterile cover-slip (24 mm. $\times$ 32 mm.) is laid over the serum, care being taken that no air bubbles pass in. The slides are collected on a wire-netting lying in a large rectangular glass dish. Below the wire-netting, wet filter-paper is spread on the bottom of the dish to prevent desiccation of the preparations. The dish is then covered with a glass lid and kept in an incubator at 37° C. The samples are examined under the microscope after five as well as after twenty-four hours.

After five hours the larvæ are very motile. In case the serum is positive, bubble-like or finely granular precipitates are seen primarily around the anterior ends of a greater or smaller portion of the worms. After twenty-four hours the larvæ are often shrunken, an observation made both in normal and in immune serum. Most precipitates are now lying free in the serum. The quantity and form of the precipitates are very variable and highly dependent on the age and size of the infection. As a rule, the reaction becomes positive between the tenth and twentieth day after the appearance of the first symptoms of the disease, which most frequently are oedema of the lids and fever. In a few cases, however, a faint reaction was obtained before the tenth day. In mild cases the antibodies seem to disappear again about a year after the patient's recovery.

Altogether, I was, by aid of the microscopical test, able to ascertain the clinical diagnosis of trichinosis in eighty patients from five different outbreaks, while in thirty other patients, clinically suspected to suffer from trichinosis, this possibility could be excluded. The test proved often to be more sensitive and more specific than the usual intradermal and precipitin tests with trichina antigen. Similar reliable results were obtained in trichinized animals, as pigs (positive already seventeen days after infection), dogs, cats, silver foxes, rabbits and guinea pigs. Necessary conditions for obtaining a clear result even in cases of very light infections are cleanness and sterility of the serum examined.

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April 3

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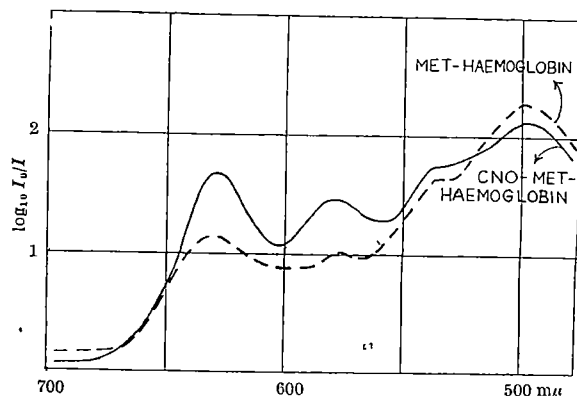
Pharmacological Action of Cyanic Acid

In the course of a study designed to investigate whether some substances known, or believed to be present, in the body, had any hypnotic action, or could contribute to bring about the internal milieu for example, water-shift) known to prevail during normal sleep¹, a marked pharmacological action of cyanic acid was found.

K M Birch and I found that sodium cyanate was well tolerated by rats, guinea pigs and rabbits in doses which produced marked drowsiness and prolonged sleep. Part of the cyanate used in this investigation we prepared from urea, we are also indebted to Glaxo Laboratories, Ltd, for a gift of pure sodium cyanate. The sleep effect produced is most evident in rats. Though the action is definitely a hypnotic one, no full anaesthesia could be produced. The L D 50 (albino rats of 80-120 gm) is of the order of 30 mgm/100 gm. Rats survived, though with increasing drowsiness, daily injections of 10 mgm/100 gm for three weeks. When the injections were stopped, the rats' behaviour soon returned to normal. No gross pathological sign could be detected in the animals. The blood sugar was normal in rabbits after two weeks of daily injections 10 mgm/100 gm, though higher doses given intravenously were followed by a small and transient rise. The body temperature showed a significant and transient fall of as much as 2°.

The hypnotic action of the drug is diminished by hyroxin and insulin. For adrenalectomized rats the drug was of greatly increased toxicity. Posterior pituitary extracts markedly increased the length and depth of sleep caused by the drug. This, however, seems to be a general effect of posterior pituitary extracts and is also evident with other narcotics (barbiturates, etc).

In more than fifty human volunteers doses of -400 mgm, taken orally, were well tolerated. The only feeling reported by the great majority was tiredness and drowsiness, which was often followed by a short and deep sleep. In many subjects we



observed a distinct miosis shortly before the tiredness was mentioned.

R Bader and I tried to investigate whether cyanic acid is a normal constituent of the body. This was claimed by Montgomery², whose findings, however, we are unable to confirm. Concerning the fate of injected cyanate in the body, a reduction of cyanate to cyanide seems extremely unlikely, because of the low toxicity of cyanate. Moreover, we could not detect, even with the most sensitive reactions (one³ with an identification limit of 0.25 γ), any trace of cyanide in the blood and tissues of animals receiving large doses of cyanate over different periods of time.

The cobalt-acetate colour test for cyanate was negative in brain, liver and muscle, but often positive in kidney extracts of animals receiving cyanate injections.

Cyanate was found not to react with either oxygen or reduced haemoglobin, but it forms a new compound with methaemoglobin. I am greatly indebted to Prof R A Morton, Department of Biochemistry, University of Liverpool, for allowing me to make use of his spectroscopic equipment, and for his invaluable help in constructing the absorption spectrum of cyanate-methaemoglobin, shown in the accompanying figure.

F SCHUTZ

Medical School,
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¹ Schutz, F, *Nature*, 153, 432 (1944)

² Montgomery, E G, *Biochem J*, 19, 71 (1925)

³ Feigl, F, "Laboratory Manual of Spot Tests" (New York Academic Press, 1943)

"High Frequency Transmission Lines"

In the review of my recently published book of this title, the reviewer¹ remarks "He [the author] gives only cryptic indication of what is actually achieved by the use of high-frequency transmission lines, and evidently expects that his readers should be satisfied to plunge into abstract study without being tempted by a recital of practical achievements."

I do not disagree with this remark, but must state in reply that considerations of national security made a fuller statement on recent practical achievements impossible, and inevitably my treatment of the subject suffered.

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¹ *Nature*, 155, 681 (1945)

RESEARCH ITEMS

Some Interesting Radulae

YOSHIO KONDO, in his paper "The Dentition of Six Syncerid Genera Gasteropoda, Prosobranchiata, Synceridae (Assimneidae)" (*Occasional Papers Bernice P Bishop Museum, Honolulu, Hawaii*, 18, No 23, 1944) describes the radular teeth of certain land shells described by C Montague Cooke, jun and William J Clench ("Land Shells (Synceridae) from the Southern Western Pacific", *Occasional Papers Bernice P Bishop Museum*, 17, No 20, 1943) *Electrina succinea* (Sowerby), and *Rapanella andersoni* Cooke and Clench were both found in the small island of Rapa but in distinct areas of distribution. The genus *Garretia* is limited to Cook Islands, the radula of *G. brangulata* (Pease) being dealt with here, *Fryanella calcephala* Cooke and Clench comes from Lau Islands, *Quadrassella mucronata* Moellendorff from Guam, Marianne Islands. All these have a very peculiar operculum characteristic of each species and differ much in form of shell. The type of radula is found to be remarkably uniform for all six. There are no lateral processes, and the teeth themselves are peculiar and distinctive in form.

Manganese Content of Fruit Tree Foliage

DIFFERENT crops vary greatly in their susceptibility to manganese deficiency, and although manganese deficiency symptoms have been recognized in the leaves of apple, apricot, cherry, peach, plum (prune) and walnut (as well as in other crops), prunes remain healthy in locations where peaches develop severe manganese-deficiency chlorosis. These differences may be due to differing manganese requirements or to variations in the ability to absorb manganese or to a combination of these factors. Of interest in this connexion are data presented by E. Epstein and O Lilleland (*Proc Amer Soc Hort Sci*, 41, 11, 1942). They report that different fruit trees, when grown under identical conditions, with manganese supplies adequate, have widely different contents of manganese in the leaves. Expressed as parts per million of dry matter of leaves the manganese contents found were for: filbert, 494, walnut, 246, almond, 96, apple, 81, prune, 73, peach, 66, pear, 63, and cherry, 62.7. Clearly, susceptibility of the peach to manganese deficiency is not due to an inability to absorb manganese as the peach leaves contain almost as much manganese as those of the 'resistant' prune.

Ascorbic Acid Content of Tomato Fruits

G B Reynard and M S Kanapaux (*Proc Amer Soc Hort Sci*, 41, 298, 1942) find that two small-fruited tomato species (*Lycopersicon peruvianum* (L.) Mill. and *L. pimpinellifolium* (Jusl.) Mill.) have a much higher content of ascorbic acid than the various types of *L. esculentum*. The ascorbic acid content of the fruits of *L. peruvianum* varied between 58.9 and 63.0 mgm per 100 gm and of *L. pimpinellifolium* between 35.9 and 47.0 mgm per 100 gm. Intermediate sized types, for example, *L. esculentum* var. *cerasiforme* (Dun.) A. Gray (cherry tomato) and *L. esculentum* var. *pyriforme* (Dun.) C. H. Mull (pear tomato) gave fairly high values, but large-fruited commercial types of *L. esculentum* gave low values (11.2–21.5 mgm per 100 gm), while within each type fruit-size and ascorbic acid content showed a negative correlation. Possibly connected with this inverse relation between fruit size and ascorbic acid content are the high ascorbic acid values which have been re-

ported for the fruits of tetraploid tomatoes, as these often have characteristically small fruits (E. C. Stan and R. K. Showalter, *Proc Amer Soc Hort Sci*, 40, 383, 1942).

Tertiary Igneous Rocks of Eastern Otago

FOR many years W. N. Benson has been making a detailed study of the Tertiary igneous rocks of eastern Otago and their tectonic environment. Five papers embodying the results to date, have recently appeared (I, *Trans Roy Soc N Z*, 71, 208 (1941), II, 72, 85 (1942), III, 72, 160 (1942), IVA, 73, 116 (1943), IVB, 74, 71 (1944)). These make a very notable contribution to the geological history, petrology and geochemistry of an extensive area centred on Dunedin. In I and II Prof Benson recognizes (a) a relatively stable region in the west, almost devoid of late Tertiary igneous rocks, though containing in the extreme north-east a great development of pillow lavas and minor intrusions of early Tertiary age, (b) a moderately deformed belt between (a) and the coast, which contains most of the rocks so far described in these papers, and (c) a strongly deformed Central or Dunedin area with Pliocene volcanic rocks belonging mainly to the basalt-trachyte and basalt-phonolite suites, these are to be described comprehensively later. II includes a summary of all the known outlying representatives of the Pliocene petrographic province from regions (a) and (b). A conspicuously differentiated sill of olivine-thermite in this group is described in detail in III. The distribution and geological setting of the Mid-Tertiary basalts, tholeiites and dolerites is dealt with in IVA, while IVB is concerned with their petrology. A special study of siliceous xenoliths and their reactions is promised in a forthcoming paper, IVC. In IVB special attention is given to the pyroxenes and the conditions governing their crystallization. The term 'subcalcic augite' is suggested for pyroxenes between pigeonite ($2V$ up to 30°) and augite ($2V < 45^\circ$). A wealth of optical detail has been provided by F. J. Turner and C. O. Hutton. The average Otago Mid-Tertiary magma corresponds closely with that of the quartz-dolerites of Scotland and the north of England, but the average Pliocene magma is considerably more alkaline and resembles that of the Lower Carboniferous province of the Midland Valley of Scotland.

The Gulf Stream and the Weather in Europe

J. W. SANDSTROM (*Ark. Math. Astron. Fys.*, 30, No 18, 1944) discusses the influence of the Gulf Stream on weather in Europe. It has been generally assumed that heat from the Gulf Stream is disseminated to the surrounding land by winds that have blown over it and are warmed. Sandstrom points out, however, that as the winds are mainly directed towards the Gulf Stream, the warmed ascending air over it being replaced by cooler air blowing from both sides of it, they cannot disseminate heat from it. The winds directed towards the Gulf Stream are deflected about 60° to the right by the rotation of the earth, their direction being from the south or south-south-west over Europe, and from the north or north-north-east over Greenland, and hence the heat produced in Europe and the cold produced in Greenland by the Gulf Stream are greater the warmer the Gulf Stream is. On the way from the tropic to the Arctic, the Gulf Stream loses a considerable amount of heat to the air and colder waters, and in order to transport any heat to the Arctic it must

convey a certain mass of water per second. The speed of the Gulf Stream was probably reduced in 1939, and hence it lost its power to produce low air pressures in the North Atlantic and southerly winds over Europe, hence the winter of 1939-40 was just as cold in Europe as in Siberia, Alaska and Greenland. The cooling of water in the Arctic, increasing its specific gravity, would cause it to sink and the surface water to set in from warmer regions, thus re-establishing the propelling force of the Gulf Stream and increasing its speed. Its waters advance rather slowly, thus in the winter of 1941-42 its warm front may not have reached farther than the south-west coast of Norway. This winter was, therefore, cold, but by the winter of 1942-43 the warm front had passed Scandinavia on its way to the Arctic, the direction of the winds over Europe became more southerly, and the winter was warm over Europe and cold over Greenland. It is suggested that a study of the Gulf Stream properties should make it a suitable medium for long-term weather forecasts.

Economics of Transformer Losses

In a paper recently read before the Institution of Electrical Engineers in London, W. Szwander discusses the valuation and capitalization of transformer losses, outlining a simple and comprehensive procedure for the practical application of the principles of economic selection of transformers. Two aspects are considered: one relating to purchase and the other to the designing of transformers to satisfy specific economic requirements in individual cases. Formulae are developed and supplemented by practical information on the selection of the correct values for the requisite coefficients. A statistical survey is made of methods used by different buyers for the capitalization of the transformer losses. Finally, approximate values of the coefficients in the formulae for the capitalization of losses are suggested, these may be used in the absence of more precise information. Of the two equivalent methods available for making an economic selection of transformers, namely, the comparison of the total annual operating costs and that of the total investment cost including the capitalized value of the losses, the first is the more popular and comprehensive. The more complicated problem of finding the most economic design of transformer to meet given operating conditions is analysed in detail. It is concluded that the economic choice of the loss ratio must be such as to ensure the annual costs of the iron and copper losses being equal, the total losses being fixed so that their total annual cost shall be about 2.5 times the total annual capital cost.

Antispasmodics

TWENTY-EIGHT basic-alkyl esters of substituted α -thienylhydroxyacetic, $C_6H_5S-CH(OH)-COOR'$, and substituted α -thienylacetic acids, $C_6H_5S-CH_2COOR'$, prepared by F. F. Blicke and M. U. Tsao (*J. Amer. Chem. Soc.*, 66, 1645, 1944), in which the substituents R' were such groups as methyl, cyclohexyl, benzyl, phenyl, p -xenyl, α -naphthyl and α -thienyl, and the basic-alkyl groups R' were β -diethylaminoethyl, 3-morpholinomethyl, β -piperidinomethyl, γ -diethylamino-propyl and γ -dibutylaminopropyl, were examined for antispasmodic activity. In general, the activity of the esters of hydroxyacetic acids on the isolated intestinal strip which had been stimulated by acetylcholine was much greater than that of the esters of

acetic acids, and some esters, especially those containing a cyclohexyl group, were equal to, or greater than, atropine in activity, a potency seldom found hitherto in synthetic antispasmodics.

Action of Sulphanilamide on Pepsin, Rennet and Urease

In a third communication on the mechanism of the action of sulphanilamide, read before the Academy of Athens (meeting of Feb. 10, 1944), N. Klissimis has examined the influence of sulphanilamide compounds on pepsin, rennet and urease. Prof. Klissimis finds that the digestion of egg albumin in pepsin solution is retarded by 'Prontosil soluble'. The clotting of milk is also retarded by 'Prontosil soluble', if the experiment is carried out in the presence of a pepsin solution and calcium chloride solution. For the work on urease, the latter was prepared according to the Van Slyke and Cullen method. The pH of the solution was stabilized with a mixture of phosphates at 7.0. The decomposition of urea was measured by the amount of ammonia developed by the reaction. This reaction was retarded in presence of sulphanilamide ('Prontalbina'). Sulphanilamide ('Prontalbina') was also effective in retarding ammoniacal decomposition of urine, the pH of this urine was very little changed.

Data on Meteors

UNDER the title, "An Analysis of British Meteor Data. Part 2. Analysis" (*Mon. Not. Roy. Astro. Soc.*, 104, 257, 1945), J. G. Porter concludes his investigations on the subject (see *Nature*, 152, 420, 1943). After a brief description of the method of classifying and grouping the material for analysis, Porter discusses the errors and their correlation and shows that errors of different kinds—sliding errors, magnitude errors and timing errors—tend to increase with the length of the path of the meteor and also with its brightness. It is not easy to explain this correlation, though in the case of magnitude errors it is suggested that the brighter the meteor the further the observer has to go for standards of reference, and for meteors of planetary brightness or more, these are usually recollected standards only. Adhering to the rules of statistical analysis, it is shown that no essential difference exists between the data for shower and non-shower meteors. In addition, the heights of comparable groups are the same and the 'seasonal effect' is merely of a statistical character. Hoffmeister's assumption of a uniform distribution of meteor paths in space is shown to be without any justification, and the non-distribution of meteor directions is responsible for the apparent seasonal variations on heights. An interesting point appears in Table VIII. There it is shown that the average shower meteor appears and disappears at greater heights than does the average sporadic meteor, a fact which Opik noticed, but the groups are drawn from very different ranges of elongation of the radiant from the apex of the earth's way, and here previous investigators have been misled. Further conclusions are that the low speeds derived from double or triple observations are real, meteors suffering some retardation by atmospheric resistance before they become visible, and that hyperbolic velocities seldom or never exist. The analysis has given the *coup de grâce* to many of the conclusions of the Arizona Meteor Expedition, and, it is hoped, has finally settled the question regarding so-called 'hyperbolic velocities', establishing beyond dispute that meteors are members of the solar system.

SIGNIFICANCE OF HYDROCARBON OILS IN CHEMICAL INDUSTRY

THE Cantor Lectures on "Organic Chemicals from Petroleum", which Sir Frank Smith delivered before the Royal Society of Arts during April, were happily timed to provide the background for wide appreciation of the importance of the recommendations of the Report of the Hydrocarbon Oil Duties Committee*, which Sir John Anderson stated in his Budget speech on April 24 he proposed to accept. The Committee, over which Sir Amos Ayre presided, was appointed by the Chancellor of the Exchequer and the Minister of Fuel and Power, as indicated in last year's Budget speech, and Sir John Anderson has now included in the Finance Bill a provision freeing from Customs duty imported hydrocarbon oils used as raw materials for chemical synthesis. Provision is also to be made for an allowance of an amount equal to the Customs duty in respect of indigenous oils used in these processes, in order that the competitive position in respect of home-produced materials should not be worsened by this change.

The Ayre Committee was appointed at the end of July 1944 "to consider and report upon (a) the effect of the hydrocarbon oil duties on the supply of raw materials to, and the development of, the chemical industry in this country so far as the use of hydrocarbons and their derivatives is concerned, and (b) the extent to which any change in those duties would affect industries engaged in the production of similar products from coal." "Chemical industry" in these terms of reference includes the producers of transformation products, such as dyes, pharmaceuticals and plastics, but excludes the industries using hydrocarbon oils as solvents only, though reference is made to the solvent-user position. Similarly, it excludes the industries concerned with the production of synthetic motor fuels and lubricants, although the Committee considered the influence of developments in this field on other modern synthetic chemical processes.

Reviewing first the effect of the duties on the chemical industry in this sense and its development, the Committee points out that while the visible direct effect of the hydrocarbon oil duties has not hitherto been large, apart from the use of petroleum oils for the manufacture of such products as wetting-agents and detergents, and of turpentine for the manufacture of so-called 'synthetic' camphor, the indirect effect has been considerable. This repercussive effect is due to the protection of indigenous oils and to the fact that benzole, one of the main hydrocarbon raw materials of the existing chemical industry, is in demand as a blending constituent, owing to its high anti-knock value, in the motor-fuel industry, where its value is regulated by that of imported duty-paid spirit. The annual cost to the chemical industry, on its pre-war consumption of 10 million gallons, which may well be exceeded after the War, is thus about £375,000 or about 1d per lb on benzole.

The consequent effect on the cost of chemicals derived from benzole depends on the yield and on the number of steps in the chemical synthesis, and may be more or less than 1d per lb on the primary intermediates. Even where the effect is less on products further removed from benzole, for example, 0.2d on some finished dyes, the increase is significant

and often serious in the export market. The Committee received evidence of the curtailment of the output of certain dye intermediates owing to the almost complete loss of the export trade resulting from this position.

Moreover, as the report notes, the organic chemical industry stands at the opening of a period of great expansion. Chemicals are increasingly providing the basic raw materials of major industries such as synthetic textiles, synthetic rubber and plastics. Since Britain possesses neither the large supplies of hydrocarbons which exist, for example, in America, in the form of natural petroleum, nor the large numbers of scientific and technical personnel trained and experienced in development work, a great effort will be called for to enable her to play a considerable part in the new industry. It is accordingly imperative that the basic and intermediate raw materials should be made abundantly available and that the industry should be free to choose the best material for each particular process or synthesis, guided only by scientific and technical considerations. Since many of the new processes utilize materials derived in part from oil and in part from coal, the growth of the chemical industry based on petroleum may also increase the demand for raw materials derived from coal, and effect of the duties may be far greater in the future, as they will tend to stifle the large-scale production of the primary and basic intermediates.

For these reasons the Committee unhesitatingly accepts the claim that the chemical industry should be able to choose its hydrocarbon raw materials free from the direct and repercussive effects of the present hydrocarbon oil duties, and the industry takes the view that it is urgently necessary that it should be relieved of this encumbrance. The Committee was also impressed by evidence of the extensive use made of the solvent properties of hydrocarbon oils in extraction processes in the industry, while its conclusion is reinforced by its survey of petroleum as a source of chemical raw materials. While the duty on heavy oil has not had any clearly recognizable effect on such developments, the duty at 9d a gallon on light oil has, and there is real danger that if the present position is maintained certain lines of development may be entirely suppressed. For example, the development of 'specialty' refining to provide the gaseous hydrocarbons, particularly the olefins containing one to four atoms of carbon in the molecule, which are the most important raw materials of the new industry, by cracking selected fractions of petroleum oils, and, by the use of aromatization processes, benzene and other aromatic hydrocarbons, will depend largely on the fiscal position. All witnesses from the oil industry urged that hydrocarbons used in the production of chemicals should be freed from duty in order that development should follow the soundest lines without being subject to artificial diversion.

A further consideration which greatly impressed the Committee was that the free growth of new industries producing and using the hydrocarbon raw materials would result in the development of new alloys, apparatus, equipment and technique which will benefit industry generally. Equally, a field would thus be provided for training chemical engineers and metallurgists, the benefit of whose experience is likely to be widely felt in many industries. The question of home refining involves considerations which lie far outside the Committee's terms of reference, but since the quantity of oil required by the chemical industry

* Cmd 6615 H.M. Stationery Office April 1945 3d net

is very small in proportion to total oil requirements, there is, as the Committee points out, no reason why home-produced oil should not play its due part in the new developments, provided the manufacturer is free to use, unaffected by duties or their repercussions, the material most suitable for his purpose.

It is, of course, to this section of the report that Sir Frank Smith's lectures are most relevant, and the importance of the matter is well shown by some of the figures quoted by Sir Frank Smith. To-day, he said, some two hundred chemicals are made on the commercial scale from petroleum raw materials, the annual value of which he estimated at about £200 millions, and in the plastics industry the ratio of petroleum derivatives to non-petroleum derivatives as raw materials is steadily increasing. By cracking processes there are already produced 60,000 tons of ethylene for the plastics industry and 120,000 tons for ethyl alcohol. The actual volume of refinery gases in the world is about 300,000 million cubic feet per annum or 15 million tons, and acetylene is already being made from petroleum and production may be on a very large scale in the future.

Sir Frank Smith contended that there is no antagonism between the coal-chemical industry and a petroleum-chemical industry, and this contention is borne out by the third section of the Ayre Committee report, dealing with coal as a source of chemical raw materials. Surveying first the low-temperature and high-temperature carbonization processes, the Committee concludes that the producer of indigenous hydrocarbons cannot and should not be called upon to bear the cost of reduction in price of his products to the chemical industry, notwithstanding that the protection afforded in 1938 to encourage the production from indigenous materials of fuels for the internal combustion engine had raised the price of certain raw materials to the chemical industry. Considering next the three chief processes for treating coal which yield raw materials for the organic chemical industry—hydrogenation, the Fischer Tropsch process for hydrocarbon synthesis (which has not yet been operated in Britain), and the production of calcium carbide—the Committee finds it difficult to forecast the part which these processes will play in the development of the chemical industry, but believes that it will not be large in the immediate future, and that its recommendations will not impede their development.

The Committee recommends accordingly that chemical manufacturers be allowed to receive without payment of duty (or upon drawback), as raw material for chemical synthesis, any imported hydrocarbon oil, and the Chancellor of the Exchequer, as already noted, indicated his intention of amending appropriately Section 2 of the Finance Act, 1934. In respect of hydrocarbon oils produced from indigenous material and received by a chemical manufacturer as raw material for chemical synthesis, the Committee recommends payment to the manufacturer of an allowance equal to the duty payable on the importation of like oils. Similarly, any producer or refiner of indigenous oils who uses such oils for the production of hydrocarbons for use in the refinery as raw materials in chemical synthesis should also receive an allowance equal to the duty payable on the importation of like oils. On the basis of the pre-war consumption of indigenous hydrocarbon oils by the chemical industry, the total cost of implementing the Committee's recommendations is estimated at something less than £400,000 a year.

In announcing his acceptance of these recommendations, the Chancellor said that many believe that synthetic chemical processes will be of rapidly growing importance in manufacture, and will affect industries outside the field of synthetic chemistry. Research on these problems has been active in several countries during the last five years, and he said he hoped that the gift he was able to make towards the cost of research by this concession will help Britain to establish itself quickly in a worthy position in relation to these new developments. While the Ayre Report does not cover the whole field—and it may well be desirable to examine the wider question of home refining in relation to national economic policy—when read with the Cantor Lectures of Sir Frank Smith, it shows conclusively that we can no longer be content to treat oil questions only as matters of Imperial defence. Equally it endorses the argument of the Parliamentary and Scientific Committee for an adequate examination of our whole policy of the utilization of our coal resources. The prompt acceptance of the Committee's recommendations is a further indication of official recognition of the importance of scientific and industrial research, and a disposition to accord scientific and technical factors their due weight in the determination of policy.

RUSSIAN PHYSICS JOURNALS

FOR a time, when transport between the U.S.S.R. and Great Britain was very difficult, the flow of scientific journals almost stopped. Recently a fairly regular exchange has been re-established. The following notes on physics journals may help those readers to whom the facilities of the London libraries are not readily accessible, but who nevertheless wish to know how physics has fared in the U.S.S.R. in recent years. On first thoughts, a knowledge of the Russian language may seem essential, but realizing the severe difficulties of their language the Russians for more than ten years have been publishing foreign editions, in German, French or English, of some of their journals. Attention will be confined almost entirely to such journals.

The earliest journal of special interest to physicists appears to be the *Physikalische Zeitschrift der Sowjetunion*, published at the rate of two volumes each year starting in 1932. Although most of the papers are in German, some papers are in English. Next to be started was *Technical Physics of the U.S.S.R.*, founded in 1934, having papers in English, German or French. By 1939 the fifth volume had been reached with a publication rate of about twelve parts a year. The centre of publication was Leningrad. In the first volume the editor, A. Joffe, explains that before the Revolution there was practically no technical physics in Russia. By 1934 a number of institutes giving their attention to immediate problems in technical physics had been established. Joffe lists them in seven groups: (1) a group of physical-technical institutes including four Leningrad institutes, Kharkov, Ural, Siberia, Dnepropetrovsk and the Physical Agronomical Institute—with one thousand workers, (2) the Optical Institute—with four hundred workers, (3) the All-Union Electro-Technical Institute with one thousand workers, (4) the Power and Thermal Institutes, (5) the Central Radio Laboratory, (6) the Metallurg-

ical Institutes, and (7) the Institute of Applied Mineralogy and others. At that time there were about three hundred technical scientific publications in Russian. The scope of the journal can be seen from the editor's list comprising (1) electron physics, dielectrics, high-voltage technique, high-frequency physics and gaseous discharge, (2) mechanical testing of materials and structure analysis, (3) thermal technology, (4) applied optics, including illumination, photography and electro-physics, (5) technical acoustics, and (6) high-vacuum physics. Scientific workers of all countries are invited to contribute papers and the editor concludes "We hope that our journal will help to eliminate the language difficulty which prevents foreigners from becoming acquainted with our work and will form yet another link in the chain drawing science and scientists of all countries together." Under the heading 'Bibliography', detailed summaries in English are sometimes given of papers appearing in Russian in other Russian journals.

In 1939, on the basis of the experience gained in publishing these two journals, the Physical and Mathematical Department of the Academy of Sciences decided to replace them by a single journal, the *Journal of Physics*, published from Moscow with S. I. Vavilov as editor. The papers were to be in English, French and German and to include all branches of physics whether theoretical, experimental or technical. The cover bears the portrait of the first Russian physicist, M. V. Lomonosov (1711-65), who was also the first to combine scientific research work with the solution of practical and economic problems. Outside contributions are invited. "We gladly offer the pages of our journal to foreign scientists who would be willing to publish their works through the medium of the *Journal of Physics*." Parts are issued monthly at the rate of two volumes each year. Fittingly the first two papers to appear are by Prof. P. Kapitza on an "Expansion Turbine Producing Low Temperatures Applied to Air Liquefaction" and "Influence of Frictional Forces on the Stability of High-Speed Rotors." The other two papers completing the first part are by A. Filippov and co-workers on "Disintegration of Atomic Nuclei of Cosmic Rays" and "Fluorescence of Aqueous Solutions of Rare Earth Salts." The last two parts of the first volume were issued together, dealing chiefly with work of L. I. Mandelstam and his collaborators and pupils, with a special article in celebration of his sixtieth anniversary. A language analysis of the first volume shows forty papers in English and five in French. The second volume has thirty-six papers in English, two in French and three in German.

At one time statements were made giving the impression that Russian physicists had to devote the whole of their attention to subjects of immediate practical use. There is no justification to be found in this journal for such statements of 'short-sighted policy'. For example, in the analytical index to volume 4, it was necessary to provide entries for the following subjects representative of all the main branches of physics: acoustics, cosmic radiation, crystalline state, dielectrics, discharge of electricity in gases, electrical conductivity, electrolytes, electromagnetic theory, electronics, Hall effect, ionization, ionosphere, liquids, luminescence, low temperatures, magnetic properties, quantum mechanics, methods, machines and instruments, nuclear structure, optical constants and properties, optical theory, photoelectric effect, radiation, radio, scattering of light, scattering of particles, spectra (molecular), super-

conductive state, thermal conductivity, vibration theory. From volume 6 onwards, the editor has been P. L. Kapitza, with E. V. Shpolsky as vice-editor. In volume 5 a new feature was started in giving a list of contents of Russian physics journals, including the titles in Russian and English, but "only those articles whose translations are not published in the *Journal of Physics*." All bibliographical details of the original Russian journals from which the full translations are made are unfortunately omitted. In format, style and content, the *Journal*, which is now being received regularly in Great Britain, is very similar to the *Physical Review*. The majority of papers are in English, with a few in French or German.

The remaining physics journals are published entirely in Russian. Recently the practice of giving also a title index and summary in some other European language has unfortunately stopped. Copies are, however, being received in Britain of several other journals of special interest to physicists. *Acta Physicochimica URSS* is similar in content to the *Transactions of the Faraday Society*, and is published almost entirely in English with occasionally a paper in French. Each volume consists of six issues and by 1944 the nineteenth volume had been reached. The chief editor is Prof. A. Frumkin, Bolshaya Kaluzhskaya 31, Institute of Colloid- and Electrochemistry, Academy of Sciences of the U.S.S.R., Moscow. Although the *Comptes Rendus (Doklady) de l'Académie des Sciences de l'URSS* covers all the sciences, almost every issue contains work by physicists. The journal is published about once in ten days. Articles are seldom longer than three or four pages, and they deal in either English or French with the very latest results of work in progress or just completed. The editorial address is Kazan, rue Baumann, 19. To science students of the Russian language this journal is of special interest, as it is a direct translation of the Russian edition. Both editions are received by the Science Section of the S.C.R., 98 Gower Street, London, W.C.1. Although the *Bulletin de l'Académie des Sciences de l'URSS, Série Physique* is published in Russian, a short abstract in English of each paper is given in the earlier volumes. By 1943, this practice had stopped, presumably owing to war difficulties.

The most complete sets of journals are to be found in the national libraries of the Patent Office, the British Museum and the Science Museum, and in the private library of the Royal Society. The British Museum has a list, which can be seen in the Reading Room, of scientific and technical periodicals received from the U.S.S.R. during 1933-42. A similar ASLIB list is out of print, but can be seen at 31 Museum Street, London, W.C.1. Perhaps the fullest abstracting service from Russian journals is that of the *Chemical Abstracts* of the United States. The fullest card-index of the present whereabouts of any particular number of a journal is that of ASLIB. This card-index is of great value to the research worker as it covers all the main libraries of the country. At present, no one library has a complete run of any current Russian journal. An index of each separate number is therefore essential, and the ASLIB index is kept up to date in step with the information supplied by the separate libraries.

A note may be added on transliteration. At least four different systems are in use in the London libraries, and even the Academy of Sciences has not yet reached uniformity, for Prof. Kapitza's name is spelt

differently in two different journals. When the controversial symbols occur in the middle of a word no harm is done. A state of affairs in which an author's name may occur under *c* in one index and *t* in another is, however, very confusing. Research workers who do not read Russian would find it well worth the small effort needed to learn the Russian alphabet and system of transliteration for, in physics at least, many of the technical terms can be recognized as soon as they are transliterated even without the use of a dictionary. Mathematics, tables of results, graphs, diagrams and photographs can therefore be recognized from the captions, which usually involve little grammatical construction. A technical English-Russian dictionary is available (by A. E. Chernukhin, State Theo Tech Pub House, Moscow, 1934), but no Russian-English technical dictionary has been published. There is at present no technical Russian grammar. The writer wishes to thank the authorities named for help in collecting the above data, and would be grateful to receive additional information or corrections of errors for which he is alone responsible.

W. H. GEORGE

POST-WAR UNIVERSITY PROBLEMS IN THE UNITED STATES

THE report of the president of Harvard to the Board of Overseers is always an important document. On this occasion¹ it is perhaps more so than usual, because Dr J. B. Conant reviews the part that ought to be played by universities in the demobilization period, and he gives an account of the Harvard proposals. British universities have been facing similar problems, and no doubt much can be gained by a consideration of what universities in the United States are proposing to do. There will always, of course, be some differences that originate from differences of outlook and position.

During the past year, Harvard has evolved the general outline of its programme, and though designed for the period of large-scale demobilization, it is equally applicable to the earlier intervening period when the number of 'veterans' is not likely to be large. Two considerations directed the planning. The first was to provide several opportunities each year for returning soldiers to enter the university without having to wait for the commencement of the next academic year, and the second was to shorten the total time necessary to complete the educational rehabilitation. Both of these are worthy considerations, though they should be regarded as essentially post-war measures and not ones that would normally be desirable under peace-time conditions. In order to achieve these ends the College and the Graduate School of Arts and Sciences will have two terms of sixteen weeks and one of twelve, and a returning soldier will be able to enter at the beginning of any one term.

Dr Conant remarks that there is little or no enthusiasm for such a programme as a permanent basis, but he does express the opinion that it is an improvement on the old pre-war 32-34-week two-term academic year.

Harvard's present 48-week academic year has produced signs of strain in the student body, and no doubt similar strains have been evident in student bodies of British universities, especially during the past four years. It would appear that Dr Conant

considers that a 38-40 week academic year is about the most suitable, because instruction is not too long nor too intensive, and there is time for reading (especially since a reading period of two weeks prior to the examinations is probably included). This contrasts with the Oxford and Cambridge year of about 24 weeks, where instruction has perforce to be intensive and the student lives in a whirl from the moment he comes up to the time he goes down. In other universities in Britain the academic year is somewhat longer and the pressure is probably not so great. The length of the academic year would seem to be a problem that should have some reconsideration in the light of present-day conditions of living.

Turning to problems of admission, Dr Conant rightly issues a warning lest academic formalities and institutional rigidity drive away men with ambition and imagination. This is probably one of the greatest post-war problems facing the universities, and it will require all the tact and understanding of those who are called upon to deal with the ex-servicemen.

There are two other items in this report that merit attention. The first concerns the appointment to life positions on the various faculties. Naturally a university tries to secure the very best qualified men, but this is by no means easy as one may see from a study of the staff roll of any university. How far a proper solution has been found can be gauged by Dr Conant's comment, "that nine times out of ten the normal forces working within any special segment of the University make for a good appointment, but against an excellent appointment. And it was President Lowell who said, 'the surest way to ruin a University faculty is to fill it with good men'". This is an important truth which universities would do well to bear in mind, and it may be that new systems for making permanent appointments need to be evolved.

The second item, which should be heartily endorsed in Britain, is a suggestion that not too long after the War a comprehensive picture should be placed before the American public of the part played by the respective universities in the war effort, "For such a picture would go far towards fortifying the faith of the nation in its institutions of advanced learning". Britain has really only begun to appreciate the value of the universities during the War, and a justification of their immediate enlarged monetary demands could perhaps be better appreciated by the general public if some similar picture of their war effort were to be presented. Beautifully illustrated brochures have been produced showing what the Navy, Army and Air Force have achieved during certain phases of the War. Could not a statement be issued showing the work of the universities? Here, however, a word of warning is necessary, and one cannot do better than conclude with Dr Conant's own words "if the story is told piecemeal and the approach is in a spirit of aggrandizement of a particular University and the claiming of a large measure of credit for this or that discovery or participation in this or that military operation, the public will soon sicken of the tale, the less glorification of the activities of the home front the better. What is said must be couched in terms of humility if it is to harmonize with the spirit of sacrifice and valour of those who bore the burden of actual combat".

V. J. CHAPMAN

¹ Harvard College Report of the President, 1943-44

FORTHCOMING EVENTS

Monday, June 25

FARMERS' CLUB (at Kingsway Hall, Kingsway, London, W C 2), at 2 45 p m—Mr J Turner "International Co-operation in Agriculture"
 ROYAL GEOGRAPHICAL SOCIETY (at Kensington Gore, London, S W 7), at 3 0 p m—Annual General Meeting

Tuesday, June 26

ROYAL ANTHROPOLOGICAL INSTITUTE (at 21 Bedford Square, London, W C 1), at 2 p m—Annual General Meeting Prof J H Hutton "Problems of Reconstruction in the Assam Hills"
 QUEKETT MICROSCOPICAL CLUB (at the Royal Society, Burlington House, Piccadilly, London, W 1), at 7 30 p m—Mr F E J Ockenden "Polarized Light"

Wednesday, June 27

ASSOCIATION OF AUSTRIAN ENGINEERS, CHEMISTS AND SCIENTIFIC WORKERS (NORTHERN BRANCH) (at Austria House, 260 Oxford Road, Manchester), at 7 p m—Dr M Ruhemann "Low Temperature Physics"

Thursday, June 28

LONDON MATHEMATICAL SOCIETY (at the Royal Astronomical Society, Burlington House, London, W 1), at 3 p m—Mr A S Besicovitch, F R S "The Problem of the Area of a Surface"

Friday, June 29

PHYSICAL SOCIETY (at the Royal Institution, Albemarle Street, London W 1), at 5 p m—Prof Ragnar Granit "The Electrophysiological Analysis of the Fundamental Problem of Colour Reception" (Thomas Young Oration) Members of the Colour Group of the Society, and members of the Physiological Society are invited
 INSTITUTION OF CIVIL ENGINEERS (Great George Street, Westminster, London, S W 1), at 5 30 p m—M Demaret, president of the Société des Ingénieurs Civils de France, on the general activities of French engineers under the German occupation

Saturday, June 30

ASSOCIATION FOR SCIENTIFIC PHOTOGRAPHY (at the Alliance Hall, Westminster, London, S W 1), at 2 30 p m—Mr H White "Make the Photograph tell a Story"

APPOINTMENTS VACANT

APPLICATIONS are invited for the following appointments on or before the dates mentioned

LECTURER IN PHYSIOLOGY to standard of Ph C and B Pharm, and a LECTURER IN GEOGRAPHY able to take work to the standard of the B A Honours and B Sc Special Examinations of London University—The Registrar, Portsmouth Municipal College, Portsmouth (June 27)

INSTRUCTOR (full-time) qualified to teach ELEMENTARY ENGINEERING, WORKSHOP PRACTICE, and the Care of Agricultural Machinery to members of Young Farmers' Clubs—The Chief Education Officer, County Offices, Chelmsford (June 30)

ASSISTANT LECTURER IN AGRICULTURAL ECONOMICS—The Registrar, University College of Wales, Aberystwyth (June 30)

ASSISTANT LECTURER IN PHYSICAL AND INORGANIC CHEMISTRY—The Acting Registrar, Queen Mary College, c/o King's College, Cambridge (June 30)

ASSISTANT LECTURER IN BOTANY—The Registrar, The University, Manchester, 13 (June 30)

SUPERVISOR AND MANAGER OF THE EXPERIMENTAL FARM, East Malling Research Station, near Maidstone, Kent—The Secretary (June 30)

INSPECTOR OF MACHINERY IN MINES AND FACTORIES, Government of Northern Rhodesia—Ministry of Labour and National Service, Central (T and S) Register, Room 5/17, Sardinia Street, London, W C 2, quoting C 2612 A (June 30)

AGRICULTURAL TRAINING OFFICER to the Cheshire War Agricultural Executive Committee—The Executive Officer, Reaseheath, Nantwich, Cheshire (June 30)

UNIVERSITY DEMONSTRATOR IN ENGINEERING—Dr R D Davies, Secretary of the Appointments Committee, Engineering Laboratory, Cambridge (July 2)

LECTURER IN GENERAL ENGINEERING SUBJECTS, and a LECTURER mainly for ENGINEERING MATHEMATICS at all stages—The Registrar, Merchant Venturers' Technical College, Bristol, 1 (July 4)

ASSISTANT ENGINEERS for the Iraqi State Railways—The Ministry of Labour and National Service, Appointments Department A 9, Room 5/17, Sardinia Street, Kingsway, London, W C 2, quoting C 2520 A (July 6)

LECTURERS (2) IN THE DEPARTMENT OF PHYSIOLOGY—The Secretary, The University, Aberdeen (July 7)

ENGINEER AND SURVEYOR to the Isle of Wight Rivers Catchment Board—The Clerk to the Board, County Hall, Newport, I O W (July 7)

HEAD OF THE DEPARTMENT OF PHYSICS AND DIRECTOR OF THE LABORATORIES in the College of Technology—The Director, College of Technology, Manchester 1 (July 9)

DIRECTOR OF SIGNALS AND RADAR DEVELOPMENT in a Government Department—The Ministry of Labour and National Service, Appointments Department, Room 5/17, Sardinia Street, Kingsway, London, W C 2, quoting D 1281 A (July 10)

SUPERINTENDENT POSTS (4) in a Government Research Establishment—Post 1 (Reference No C 2656 A) candidates should be well qualified in PHYSICS with a knowledge of Mechanical and Electrical

Engineering and a wide experience in research work, Post 2 (Reference No F 4376 A) candidates should be well qualified in the CHEMISTRY AND PHYSICS OF EXPLOSIVES and should have experience in handling and filling of explosive stores Post 3 (Reference No F 4377 A) candidates should have a wide knowledge of PHYSICS and PHYSICAL CHEMISTRY with considerable experience in research in one of these subjects, Post 4 (Reference No A 943 A) candidates should possess high academic qualifications in APPLIED MATHEMATICS, MATHEMATICAL PHYSICS and considerable experience of theoretic research—The Ministry of Labour and National Service, Appointments Department, Room 5/17, Sardinia Street, Kingsway, London W C 2, quoting the appropriate Reference No (July 10)

CHIEF ENGINEER in a Government Establishment dealing with the design of Armaments—The Ministry of Labour and National Service, Appointments Department, Room 5/17, Sardinia Street, Kingsway, London, W C 2, quoting C 2657 A (July 11)

Grade II(b) LECTURER IN MECHANICAL ENGINEERING—The Secretary, The University, Birmingham, 3 (July 31)

DIRECTOR OF THE INSTITUTE FOR RESEARCH IN AGRICULTURAL ECONOMICS, University of Oxford—The Registrar, University Registry Oxford (August 4)

SECRETARY TO THE INSTITUTION OF NAVAL ARCHITECTS—Council the Institution, 10 Upper Belgrave Street, London, S W 1 (August 3)

ASSISTANT IN THE DEPARTMENT OF CHEMISTRY, with special knowledge of Physical or Inorganic Chemistry—The Secretary, The University, Aberdeen (October 1)

TOBACCO EXPERT as head of the Agricultural Section of the Directorate General of Tobacco Monopoly of the Government of Iraq, improve varieties grown and study picking, drying and packing, able to carry out experimental work on the selection of seed and soil The Ministry of Labour and National Service, Appointments Department, Sardinia Street, London, W C 2, quoting O S 873

WARDEN AND ASSISTANT LECTURER IN AGRICULTURE at the Ké Farm Institute, Sittingbourne, Kent—The Principal

CIVIL, MECHANICAL AND ELECTRICAL ENGINEERS in the Colonial Engineering Service—The Director of Recruitment (Colonial Service) 15 Victoria Street, London, S W 1, or the Ministry of Labour and National Service, Room 5/17, Sardinia Street, London, W C 2, Appointments Dept A 9

GENERAL AGRICULTURAL OFFICERS and also SPECIALISTS IN PLANT PATHOLOGY, GENETICS, etc, for service overseas in the Colonial Agricultural Service—Director of Recruitment (Colonial Service), Victoria Street, London, S W 1, or Ministry of Labour and National Service, Room 5/17, Sardinia Street, London, W C 2, Appointments Dept A 9

A PROFESSOR OF CIVIL ENGINEERING, and a PROFESSOR OF MECHANICAL ENGINEERING at Canterbury University College, Christchurch, New Zealand—The Secretary, Universities Bureau of the British Empire, c/o University College, Gower Street, London, W C 1

TEACHER OF MECHANICAL ENGINEERING SUBJECTS, and a TEACHER OF ELECTRICAL ENGINEERING SUBJECTS qualified to teach both A and D C to National Certificate standard—The Principal, Technic College, Talbot Road, Stretford, Lancs

GRADUATE TEACHER FOR CHEMISTRY, and a GRADUATE TEACHER FOR MECHANICAL ENGINEERING SUBJECTS—The Principal, Cumberland and Technical College, Workington

PHYSICIST to the Stoke-on-Trent Regional Radium Centre—The House Governor, North Staffordshire Royal Infirmary, Stoke-on-Trent

GRADUATE MISTRESS FOR BIOLOGY—The Principal, County Secondary School, Workington, Cumberland

LECTURER IN GEOGRAPHY, and a LECTURER IN SOCIOLOGY, at the Portsmouth Training College—The Registrar, Municipal College Portsmouth

ASSISTANT MASTER IN THE JUNIOR TECHNICAL SCHOOL, qualified to teach Science and Mathematics—The Principal, Royal Technic College, Salford

REPORTS and other PUBLICATION:

(not included in the monthly Books Supplement)

Great Britain and Ireland

Conference of Nature Preservation in Post-War Reconstruction Memorandum No 3 Report by the Nature Reserves Investigation Committee—Nature Conservation in Great Britain Second edition Pp vi+25 (London Society for the Promotion of Nature Reserve British Museum (Natural History), 1945) 6d

Programme of Leave Course on the British Police System for Members of the Allied Forces Arranged by Chief Constable of Southampton and the British Council, at Southampton Police Headquarters Pp 12 (London British Council, 1945) 1s

Careers for Men and Women a Brief Summary of Profession Opportunities Open to Service Personnel and War Workers Pp iv+28 (London Ministry of Labour and National Service, 1945) 1s

Other Countries

Smithsonian Institution War Background Studies No 21 The Aleutian Islands, their People and Natural History, with Keys for the Identification of Birds and Plants By Henry B Collins, J Austin H Clark and Egbert H Walker (Publication 3775) Pp iv+128+21 plates Miscellaneous Collections, Vol 104, No 9 C 27 0074-day Cycle in Washington Precipitation By C G Abbe (Publication 3800) Pp 2 Miscellaneous Collections, Vol 104, No 10 Influence of Various Substances on Sugar Determination, Copper and Ferricyanide Reagents By Robert L Weintraub, A Leonard Price (Publication 3801) Pp 20 (Washington, D C Smithsonian Institution, 1945) 1s

Reports of the Biochemical Research Foundation of the Frank Institute Vol 7, 1942-1943 Pp 294 (Newark, Del Biochem Research Foundation, 1945) 1s

NATURE

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SOCIAL SCIENCES AND THE CIVIL SERVICE

THE future position of the Civil Service in Great Britain turns on two fundamental factors: first, the adequacy of the methods at present in use in the Civil Service for handling the new and wider range of problems with which it is called upon to deal in the discharge of a new and more positive conception of government, and what changes, if any, are required to enable it the better to discharge those functions; secondly, the capacity of its personnel to handle those problems constructively, imaginatively and efficiently, with its corollary, the consideration of methods of the recruitment, training and tradition of the Service. It is not, of course, possible to separate questions of methods and men in practice quite so sharply. The personnel of a Civil Service may be defective because of lack of inherent capacity, but the presence of competent or incompetent officers in the Service and their subsequent attainments are determined largely by the methods of recruitment and training employed, just as the tradition of the Service has a large influence on its attractiveness as a career for the ablest minds and finest characters in the community it serves. Equally, it is true that no perfection of administrative methods and machinery will ensure efficient functioning unless the Service attracts administrative ability as well as integrity.

No serious criticism of the Civil Service, however, can ignore the fact that the extension of Government activities has come to stay, the social service State, the implementation of a policy of full employment, calling for a more positive conception of government, will impose fresh demands on the whole machinery of government as well as on the men to whom the actual work of government is entrusted. Leaving on one side the question of machinery, we have to ask ourselves, first, whether we are getting into the service of the State a sufficiently representative sample of the highest ability available, and then, having recruited from all possible quarters the right material, whether we are making the most effective use of that material.

These are the questions with which in the main Dr. E N Gladden is concerned in his recent book*, but his contribution is disappointingly small. He recognizes that the War marks a great change in the social structure of our world and that to-morrow's needs will require a new Civil Service for their fulfilment. But while he asks the question whether our present administrative machine is flexible enough to meet these new needs, and contributes an admirably lucid account of the evolution of the national administration and of recent criticism of the Civil Service as well as of its development in Great Britain, his analysis scarcely seems to go deep enough. He says the right things about official integrity and detachment, the method of open competition, and the like without being platitudinous. His review of recruitment is eminently sound, with its pertinent reminder that while the interviewing methods adopted

* The Civil Service: Its Problems and Future. By E N Gladden. Pp 164 (London: P S King and Staples, Ltd, 1945) 10s 6d net.

Editorial and Publishing Offices

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by the Civil Service Commission have been found satisfactory, it is doubtful whether the conditions of a short interview can have permitted a really high degree of objective accuracy to be attained.

Similarly, Dr Gladden's review of training rightly emphasizes that normal methods of open competition pre-suppose a complete system of post-entry training, but while he admits that such training, especially that by encouragement, is largely absent, he gives little if any indication as to how this should be remedied. For a successful system, he points out, two changes would be essential: first, a new attitude by those in control, and, secondly, a Civil Service which would permit the advancement of the talented man more effectively than the present system. He criticizes the introduction of the training grade of the executive class as having too long a salary-scale and numbers too high in proportion to the higher grades of the class, and his discussion of promotion questions is likewise critical rather than constructive. It exposes the weaknesses in the assumptions upon which the use of a seniority list as the only basis of promotion rests, without indicating the measures which might be taken to increase the validity of those assumptions. Again, he points out that the qualities required for promotion, at least to supervisory posts, are not easily subjected to the examination process, and he recognizes the importance in a democracy of tapping the largest possible recruitment area.

Dr Gladden's own proposals, to which the second part of the book is devoted, are designed to overcome some of these difficulties. The Civil Service organization must fulfil four requirements: it must be capable of meeting the functional aims for which it has been created; it must be synchronized at the recruitment stage with the school-leaving ages as prescribed by the different strata of the educational system; it must be able to meet the long-term changes postulated both by the alterations in the social environment and by the general development of administrative technique; and it must, while conforming to a centralized plan, be capable of meeting the various special demands of the separate departmental units. Briefly, Dr Gladden proposes to secure this by constituting a new general clerical class to cover the present clerical-executive-departmental field, and by recruiting up to 50 per cent of the administrative class within the Service. The general clerical class would be divided into ten seniority or salary groups common to the whole Service, and for promotion purposes, group seniority would replace individual seniority. Recruitment from outside would be to the lowest three groups, the examination being cast on the present lines to obtain candidates from the primary plus stage, from the intermediate secondary stage and from the higher secondary stage. The scheme would provide for demotion, where necessary, for effective probation, and for transfers between Ministries to be arranged by a personnel organization board which would also control the staffing of new Ministries. A central training committee would be established and the study of public administration encouraged.

Without entering too deeply into the details of Dr Gladden's proposals, and whether they are likely to secure all that he desires, it is clear that he recognizes the extent to which the chief problems of personnel organization reside in the management of the administrative rank and file, in the application of general rules to staff and in the selection therefrom of individuals for special tasks and positions. While his scheme may well ensure that the principles of objectivity in staff selection, both in recruitment and promotion, continue to be rigorously applied, it may be questioned whether they offer any real contribution towards the increase of flexibility of the Service where questions arise of taking into the sphere of government new institutions hitherto outside the State's orbit. Despite the wide range of his final chapter with its clear recognition of the new and wider functions of government, of the necessity for new social incentives, the importance of individual efficiency and of the place both of expert and administrator in government—the only expert, he says pertinently who bids fair to rule is the propagandist, without whose aid no dictator could rise to power, no government maintain its position, and no new programme gain the adherence of the crowd—Dr Gladden is somewhat superficial. His conclusion that quite a modest measure of reform should suffice to fit the Civil Service to the superhuman tasks with which the nation's administration will be faced in the period of reconstruction is not altogether convincing.

Indeed, Dr Gladden's book can be contrasted with a modest little study by Elizabeth Macadam*. Her brief review of the provision of training for the social services, to which Mr S. W. Harris contributes a foreword, well illustrates the limitations of Dr Gladden's book, although Miss Macadam is addressing herself specifically to a more limited problem, the importance of which was specially emphasized by Sir William Beveridge in his report on social insurance and allied services. The success of a social security policy will ultimately depend largely on efficient administration, and such administration in its turn depends not only on the efficiency of rank and file workers responsible for active work and personal contacts, but also on the quality of the numerically much smaller administrative staff responsible for direction and policy.

This aspect of the Civil Service has already attracted attention. It was ably discussed, for example, by Mrs Joan S. Clarke in a chapter "The Staff Problem", contributed to the volume of essays entitled "Social Security" edited by Dr W. A. Robson, and Mrs Gertrude Williams has some pertinent observations in the final chapter of her study "The Price of Social Security". Mrs Williams emphasizes the necessity of quantitative thinking by the administrator to supplement the principles of the use of powers conferred by law. For this, the Civil servant requires more knowledge of the workaday world, and the content of his mind as well as its quality is important. More and more it is required of the Civil Service administrator that he should be

* *The Social Servant in the Making*. By Elizabeth Macadam. P. 146 (London: George Allen and Unwin, Ltd., 1945) 6s.

not only more competent to deal with situations as they arise, but also that he should know how to create the situation by looking ahead and preparing for it. Well may Miss Macadam observe, of objections to proposals to recruit older men and women to the administrative class, that something must be wrong with the machine of government if a few years work outside Whitehall makes a man too old at thirty to acquire a knowledge of its technique.

Miss Macadam, recognizing that social services have no hard and fast boundaries, strongly supports the plea originally advanced by Sir Ernest Barker that the higher administrative posts of the Civil services should be opened to a maturer type of candidate than those who successfully pass a competitive examination at an early age. This, in her opinion, is an essential step towards a modernized and socialized Civil Service, and the Government's proposals already announced in the White Paper on recruitment during the reconstruction period are a move in this direction. Next, she considers the university as the appropriate centre for training, and holds that every university should have its school of social study, though not necessarily the same equipment or identical aims. Schools in great cities, for example, will tend to become centres of instruction and research on a large scale. Oxford has opportunities for the study of rural conditions from its centre at Barnett House, while Manchester, Glasgow and Leeds should become centres for training in industrial personnel and welfare.

All this, of course, would implement the provision and admission of economists, sociologists, psychologists and statisticians, which has been emphasized by Mrs Joan Clarke as so important now that constructive long-term thinking and exercise of the newer mental disciplines have become a government function of the first importance. Again, if organized courses for junior Civil servants on the lines of the staff college idea are established, Miss Macadam suggests that they would be better held at universities than concentrated at a special institution. The modern university is not so segregated that courses of study for public service on the lines laid down in the British Association Committee's report would fail to attract many different types of candidates or to offer opportunities for very varied contacts.

Some of these suggestions of Miss Macadam clearly deserve closer consideration in planning the post-war development of the universities of Britain. The establishment by the universities of sub-centres of social study in areas out of reach of a university is more a matter for inter-university discussion than for independent action, as is also the specialized development of social study schools, while her reference to the need for a National Institute of Social Studies comparable with the Royal Institute of International Affairs points to a further problem in which co-operative planning will be required to avoid overlapping in research.

But there is a further reason for more deliberate planning and co-operation in this field. Unless the special fields of the social study schools of the universities are planned in co-operation in some such

way, there is danger that the individual schools will not receive a sufficient regular supply of students. Moreover, as Miss Macadam again points out, while the content of mind is important, quality is important also, and we shall not attract the best type of entrant unless we open up wider possibilities of promotion in the Civil Services for those who qualify in this way. More sources of financial help during training are also needed, but above all it is imperative to remove the deterrent of the relatively low salaries and limited opportunities of promotion at present available to those who enter the statutory social services. Nor should it be forgotten, as Miss Macadam reminds us, that this applies to the local government service also, where a socially trained administrative staff is equally important. Trained practitioners in the social sciences or in any other field of science may be ineffective if those under whom they serve have no conception of what social or scientific work means. There could be no more convincing demonstration of this than the difficulties which the proposals of the White Paper for a National Health Service have encountered through the well-founded distrust of the medical profession of local government administration. Had a sufficiency of administrators of the right outlook and training made their influence felt throughout that service, the whole reaction of the medical profession to the Government's scheme might have been fundamentally different.

Of the two books referred to above, Miss Macadam's appears to deal with the more fundamental issues in spite of its professedly narrower scope. She is more suggestive and her observations on the contribution of the university are a real contribution to the discussion of the place of the university in the modern world. Recognizing the grave danger of isolation in the teaching of particular aspects of social problems, especially those dealing with abnormalities and liable to fall completely out of focus when treated separately, she urges that university control provides a guarantee against the equally real danger of political or other forms of propaganda. The fact that social politics border so nearly on party politics is a strong reason why candidates for training should come under the influence of men and women who can be expected to preserve as impartial an attitude as possible. Both books draw freely on current reports and criticism of the Civil Service, though Miss Macadam's book might have been better documented, and Dr Gladden's select bibliography unfortunately omits reference to the British Science Guild's report. While they make little fresh contribution to the discussion, they nevertheless disclose the fundamental principles which must be followed in moulding the Civil Service in Britain to meet the needs of the future. The type of personnel required is already becoming clear. The traditional integrity of the Service must be maintained, and its members, from the highest grade to the lowest, must approach their tasks in the knowledge that they are indeed servants of the community. In addition, they must be imbued with a spirit of endeavour, and able to recognize the needs of the swiftly changing character of the world in which we live.

DISTRIBUTION PATTERNS

Maps for the National Plan

A Background to the Barlow Report, the Scott Report, the Beveridge Report. Prepared by the Association for Planning and Regional Reconstruction. Pp. iv+120 (London: Lund, Humphries and Co., Ltd., 1945) 15s

THE title, "Maps for the National Plan", may perhaps mislead purchasers of the work under review, for its anonymous compilers are members of a fact-finding group, and the maps in question do not present a plan, but have been chosen simply as furnishing in visual form a large collection of data deemed to be relevant to planning. In order to drive home their relevance, each map is faced by a column of verbatim extracts from the Barlow, Scott or Beveridge Reports, and these are usually well chosen, although the relation of catchment board boundaries to defective rural water supply seems a trifle tenuous.

The area covered is that of England, Wales and Scotland (excluding the Orkney and Shetland Islands), and all but one or two maps are gridded in accordance with the system adopted by the Ordnance Survey. On the key map entitled "Chief Urban Areas" the grid is ruled at 10-kilometre intervals, and this map is duplicated on a stout transparency, so that it can be laid over any other map in the series. It will prove rather a handicap to users that none of the counties, and very few of the towns, are named, which means that the maps must be used with an atlas. A second transparency, showing the "Distribution of Population" according to the Registrar-General's estimates for 1938, also loses much of its usefulness owing to the very unintelligent use made of the so-called 'dot method' of statistical mapping, one that has limitations which by now should be sufficiently well known. On a large number of the maps, however, the cartographical devices employed are undoubtedly fresh and effective, and the whole style of printing and production is at a very high level, especially by war-time standards. The method of binding, which certainly has the advantage that the maps lie perfectly flat, as well as the finished appearance of the maps themselves, is a reminder that a close scrutiny of a 'planner' usually reveals, not a lover of books or learning, but an architect or an engineer. Tribute has, however, been paid to the scholar's methods, for in an appendix the sources drawn upon for each map are carefully listed, and where necessary supplementary statistics and diagrams are supplied.

The analysis and interpretation of the maps is, however, left entirely to the reader, and this he may find difficult unless he is already accustomed to map techniques. Why, he will ask, could not the same information have been presented in literary form? The short answer to his question is this: Maps can reveal, as neither words nor figures can, whether or not a particular distribution shows 'pattern'. If the distribution, say of unemployment, is uniform or haphazard, it will show no pattern, if it is influenced either directly or indirectly by geographical location, it will. Maps such as these do away with the idea that industry, save for mining and shipbuilding, can 'go anywhere', and map techniques are now being employed in various Ministries to investigate this extremely complex problem of location. The basic pattern of any country is determined by its geological

structure, which shows itself most clearly in the disposition of surface relief and drainage, soils and mineral resources. Surface relief and drainage in their turn underlie accessibility, while population aggregates, from villages up to conurbations, are usually found to be rooted in some combination of accessibility and resources, the latter including water supply and soil quality. Sir Halford Mackinder long ago pointed out the fundamental contrasts between the geologically older west and north-west of Britain and the geologically younger east and south-east. The network of traffic links between the two, at its densest in the axial belt running from the metropolitan area to the Mersey, provides a zone of superior accessibility, the importance of which can be traced now clearly, now dimly, through many of these maps. There is little doubt that the inaccessible location of the uneconomic location so far as industry is concerned, and also the undesirable location so far as the majority of gregarious mortals see it.

There is small warrant, therefore (security from attack apart), for the widespread ruralization of industry which many planners desire to see. A map, entitled "Country Towns Selected for Development" the only didactic one in this collection, should be examined in conjunction with the maps showing amenities and services, including, for example, the electric grid, medical men and secondary schools. The authority for this map is Mr A. E. Smailes, whose published work (cited in relation to several other maps) is scarcely deep or searching enough to make him altogether a safe guide to follow.

It would be easy to find fault with these maps in detail: the economist would query this, the statistician that, the geographer something else. But looked at as a whole, the book is stimulating, and challenging. Here are matters which must be considered, which will be neglected at our peril. Who, for example, will be able to pass over lightly the pair of maps showing the proportion of the young to the old in 1911 and 1931 respectively? True that, by a perverse blindness to the importance of cartographical conventions, the areas proportionally richest in children in 1911 are shaded in deepest black, but in 1931 there are no such 'black spots'.

E. G. R. TAYLOR.

FOURIER AND TAYLOR SERIES

Lectures on the Theory of Functions

By Prof J. E. Littlewood. Pp. viii+243 (London: Oxford University Press, 1944) 17s 6d. net.

THE material of these lectures is drawn from the most central and fundamental of recent developments in the general theory of functions of real and of complex variables. The introduction and Chapter are already well known to the author's students, and will now be especially welcomed by a wider circle.

The introduction is mainly devoted to functions of a real variable and includes sections on inequalities, the analysis of function classes in relation to integration and generalized convergence, Fourier series, and harmonic functions of two variables, and gives in relatively few pages a remarkable amount of these extensive subjects. There is also a special study of some curious power series. Chapter I deals with the foundations of the maximum modulus principle and the convergence properties of sequences of analytic

functions, but is mainly concerned with the theory of conformal representation of simply and multiply connected domains in a plane including the correspondence of the frontiers. Many accounts containing more or less the same subject-matter have been published; but the present one is notable for the great care which has been taken with the proofs and explanations of the subtle and difficult features with which the subject abounds.

The first volume ends with Chapter 2, which has been rewritten and extended with the collaboration of Dr Rogosinski. This commences with a brief but substantial account of the theory of subharmonic functions, and for the rest is concerned with a special group of comparatively recent discoveries based on the notion of 'subordination'. In elementary calculus we are accustomed to argue from geometrical properties of the curve representing a function to properties of its derivatives or integrals and vice versa. The analogous process for differentiable functions of a complex variable is more elaborate because of the four-dimensional nature of the geometrical representation, and because the values of the function and its first derivative even at a single point influence their behaviour throughout their whole region of existence. This property (exhibiting power series and Fourier series in sharp contrast) is illustrated by a discussion of some of the simpler results related to Bloch's theorem. If, on the other hand, the values taken by the function are in any way limited, then its rate of growth at maximum, in the average, and in terms of its differential coefficients is correspondingly restricted. This consideration is developed in the "Lectures" for functions the values of which omit certain regions, curves, or isolated points, including in particular the author's own theorems on functions omitting a sequence of points and the proof of the Bieberbach conjecture in special cases.

The book possesses two very unusual features which overshadow the mere contents in importance and distinguish it from the more common compendium of (sometimes inadequate) quotations. One is the extreme care which has been taken over every detail of logic and presentation, and the other is the remarkable artistry with which so many different aspects are arranged in a logical and readable sequence. It is therefore unfortunate that bibliographical references of the customary standards have not been added on publication of the "Lectures".

A. J. MACINTYRE

MODERN METEOROLOGY

Descriptive Meteorology

by Prof Hurd C Willett Pp viii+310 (New York: Academic Press, Inc., 1944) 4 dollars

WEATHER is still one of the major factors in war, air warfare especially has resulted in the intensive teaching of meteorology on an unprecedented scale. Teaching requires books, and the last few years have brought a number of excellent textbooks, mostly from the United States, where lavishness in printing is still possible. The latest example, by Prof H C Willett, maintains the high standard, is excellently printed on good paper, well illustrated, and, more important, it is lucid, readable and completely modern. The arrangement follows the usual

lines for a text-book of physical and dynamical meteorology (the title "descriptive" is over-modest), it begins with definitions, the composition of the atmosphere and the effects of vertical movements under adiabatic conditions. Chapter 3 deals with the heat balance of the atmosphere and includes a revision of the classic diagram due to W H Dines, which embodies the most recent data but is not quite so clear as its prototype. There are two striking vertical cross sections of the atmosphere over North America from 72° to 18° N, based entirely on *radio-sondes*.

The next two chapters, on evaporation and condensation, and wind velocity, are on accustomed lines and do not call for comment, but the treatment of the general circulation in Chapter 6 is of great interest. The vertical cross-sections of temperature and pressure are used to reconstruct the zonal geostrophic winds above North America, but these diagrams are not clearly explained, moreover, they could profitably be supplemented by sections showing the variations of the observed winds with height. Charts of observed normal winds at 10,000 feet are given in a later chapter, but these afford only a very limited comparison. From these sections the author comes to the unorthodox conclusion that the variation of height of tropopause with latitude results from the dynamics of the general circulation and not from the strong heating of the tropics.

"Secondary circulations" include the rather odd grouping of monsoons and hurricanes. The account of the Asiatic monsoons is perhaps over-simplified, for example, the author implies that there are no rain-producing agencies in central China in winter, omitting mention of the storms associated with the passage of shallow continental depressions. The account of the development of a hurricane is excellent, especially the analysis of the conditions within the 'eye' of the storm.

The chapter on air-mass characteristics contains a good deal of new matter, including sub-categories for stable and unstable air based on thermal stratification at high levels, which make a useful extension of the earlier classifications. It is now recognized that "air masses which come from the same source region at the same season and by the same trajectory may differ greatly in their upper level stratification". The world charts of air-mass source regions are of great interest, but need to be studied in relation to maps of the prevailing winds. Unfortunately such maps do not appear anywhere in the book—a notable omission which ought to be remedied. Extra-tropical depressions, both surface and upper air, come under the heading of "secondary circulations of dynamic type", and along with much that is familiar, include a good deal of recent analysis of upper air conditions. "Tertiary circulations" embrace a miscellany of phenomena, from land and sea breezes to tornadoes, there is a new theory of the Föhn as primarily a change of air-mass rather than a result of dynamical warming. The book ends with a chapter on synoptic representation and a sketchy section on forecasting.

From this brief account it is evident that Prof Willett has achieved something of a feat, at a time when meteorology is developing rapidly he has almost completely eliminated the usual lag between the publication of research in the scientific journals and its appearance in text-books. No doubt this is largely due to his own activities in one of the storm-centres of research.

C E P BROOKS.

A Background of Physical Geography

By George P. Kellaway Pp viii+232 (London Macmillan and Co., Ltd., 1945) 8s 6d

THERE is need for more attention being given to the physical basis of geography in school work, too great attention to the human side, with neglect of the background, may encourage a subjective approach. This short volume is an attempt to supply the physical background for higher school and intermediate university geography.

The book covers a wide field with different degrees of emphasis. Broadly speaking, half of it deals with land features and the oceans, and half with the atmosphere. After the usual introductory matter on the earth as a planet, there follow a few notes, rather too brief, on theories regarding the earth's origin and kindred matters; Wegener's theory and isostasy, each in one page, are compression carried to excess. Of the chapters on land forms and land sculpture, the least satisfactory is that on islands, where some revision is required in the sections on volcanic islands and coral islands. Darwin's theory of reef growth is not the only one. The chapter on the oceans is short and comprehensive, but the author should note that icebergs are never formed from sea-water. The term is not used for sea-ice. Since the temperature and salinity of ocean water are discussed, it would be well to consider the bottom water and its origin.

The final chapters, on climate, are the best part of the book, though it is not clear to the reviewer why a discussion of climatic regions should be headed "Natural Regions of the Earth." Reliable information concerning the true polar regions is not so scanty as the author suggests, and is quite adequate for a clearer view of polar climates, both north and south, than is given here. It is high time that the old well-worn and misleading diagram of the planetary winds, as they would be on an ideal water-covered globe, was abandoned. The notes on vegetation, given for each major climate, should, for students of geography, be more explanatory and not merely descriptive.

The book is well illustrated, and on the whole may serve the purpose for which it is intended.

Introduction to Quantum Mechanics

By D. E. Blochintsev (In Russian) Pp 484+79 plates (Moscow and Leningrad Unified State Publishing Co., 1944) 18 roubles

THIS modestly named volume is in fact a comprehensive treatise covering the whole subject of quantum mechanics. It summarizes the relevant basic discoveries of Planck, Compton, Einstein and Bohr in convenient mathematical form.

The chief sections are: basic principles of quantum theory, wave mechanics, relations between quantum mechanics, classical mechanics and optics, theory of movement of particles in a field of force, movement of charged particles in an electric field, theory of continuous spectra, radiation, absorption and dispersion of light by atomic systems, secondary quanta and quantum statistics, magnetic phenomena.

A series of appendixes summarizes and clarifies the mathematical framework of the treatise. There is an adequate subject index. Bibliographical notes are interspersed as footnotes.

In spite of the poor-quality war-time paper, the volume is a dignified one. The printing of extremely complicated mathematical functions has been well done.

Five-Figure Logarithm Tables

Containing Logarithms of Numbers and Logarithm of Trigonometrical Functions with Argument in Degrees and Decimals Pp iii+188 (London H.M. Stationery Office, 1944) 7s 6d net

THIS collection of five-figure tables has been compiled, as a war-time measure, to meet the ever-increasing demand, both in industry and elsewhere, for accurate numerical information of this kind.

The book is divided into three distinct parts. The first of these (occupying seventy-three pages) is a reproduction, from stereotype plates, of Chappell's table of logarithms, which gives five-figure logarithm of the numbers 10,000 to 40,000 and then those of 4,000 to 10,000 in that order. The second section is a photolithographic copy of von Rohr's table of five-figure logarithms of sines and tangents of small angles, over the range from 0° to 5°, for intervals of one thousandth of a degree in each case. Lastly there is a similar reproduction of Bremiker's table of five-figure logarithms of sines, tangents, cotangent and cosines of angles from 0° to 45°, for intervals of one hundredth of a degree in all cases. A table of constants is also appended.

Having regard to the urgent necessity for conserving paper supplies, it was considered unnecessary to provide a continuous pagination and the pagination of the three component tables has therefore been preserved unchanged. The original prefaces and explanations have also been omitted, and no instructions for the use of any of the tables have been supplied. The von Rohr and Bremiker tables have been reproduced with the authority of, and under licence from, the Custodian of Enemy Property.

It is worthy of note that the standard of reproduction and printing is very high.

J. H. PEARCE

Gardener's Earth

An Introduction to the Study of Soils for the Every-day Gardener By Dr Stanley B. Whitehead Pp viii+231+24 plates (London J. M. Dent and Sons, Ltd., 1945) 7s 6d net

THIS is an interesting production, one of the better class of books on gardening written for the non-technical reader. Although it is mainly about soil, it covers a wider ground, including manures and fertilizers, pests and diseases and crops. In conformity with the title of the book, the discussion of these subjects is based on their soil aspects, this form of treatment has led to some repetition, both between and within chapters, that calls for pruning when a new edition is prepared.

In his discussions of soil moisture and cultivation the author has fairly presented the results of modern research and technological investigations, in consequence, the alluring but inadequate picture of the soil pore-space as a bundle of capillary tubes finds no place in his exposition. The discussion of organic manures and artificial fertilizers is less happy. The non-technical reader may well wonder why the full (and excellent) account of artificials and their use is included, in view of the blunt statements about them in the chapters on the virtues of organics, and it is a little unfortunate that the objective and scientific treatment maintained over the greater part of the book is occasionally obscured in these chapters. With these reservations the book can be given a welcome. A special word of praise is due for the excellent illustrations.

B. A. K.

PLANT PATHOLOGY: TEACHING AND RESEARCH*

By PROF W. BROWN, F.R.S.

WE are now, we hope, approaching the realization of peace and of that kind of atmosphere in which biological work, and more especially research, can hope to flourish once more. We have every reason for believing that the next few years will see many changes—changes in our educational system at all levels, with resultant effects upon students who take up an applied biological profession, and changes in our agriculture which will lead to a different emphasis upon instruction and research in biological subjects. With these changes impending, it may therefore be opportune at this time to look back over the years of one's experience, and see how far the old system appeared to be satisfactory and where on the other hand it did not give the results which might have been expected.

As the scope of plant pathology varies somewhat from place to place, it will be well, first of all, to say a few words on this topic. My own experience has been substantially in the region of mycological plant pathology, that is, I am a plant pathologist in the narrower sense which is current in Great Britain, as for example in the calendars of universities and agricultural colleges. This narrower definition leads to difficulties in practice, as for example in delimiting the respective spheres of the plant pathologist and the agricultural entomologist in the study of insect-borne diseases. It is much better, I think, to use the words 'plant pathology' in a wider sense, and to mean by it the study of the plant in disease, whatever the cause may happen to be.

On this topic of definition, I would venture to go even further towards generality. The word 'disease' as it comes to acquire rather a special meaning, and to most people implies more than mere 'unsatisfactoriness'. I would be prepared to stake a claim as follows. Wherever a plant (or a plant product) is unsatisfactory for any reason whatever and in any respect whatever, as for example when the yield has been smaller in quantity or less desirable in quality than might reasonably have been expected, there one sees a problem for the plant pathologist. No doubt it would be very easy to state problems which fall within this widest scope and which would sound seriously if labelled 'plant pathological'. Such matters appeal to me as details, and the important point is to recognize the unity of aim, which is to achieve more and more control over the plant in certain desired directions. The technicians employed must of necessity be various—entomologists, geneticists, mycologists, soil chemists and others—but they are all harnessed to the one major purpose, the production of more and better plants. I need scarcely add that this is the main interest of the public, who apply in the long run the funds which render our work possible.

I have put in my title the phrase "Teaching and Research". The two are not easily separable, for there is general agreement that teaching will not long survive if the research side is dead. The necessity of research in a teaching institution, quite apart from the desirability of keeping the name of the place

upon the map, is all the more compelling if it is agreed that the object of teaching is not so much to inculcate a mass of facts which may soon be forgotten, as to instil methods of handling facts, and where possible of discovering new ones.

It would take too long to go into any detail as to what I think is the most desirable pre-graduation training for a man who intends to take up plant pathology as a career. The old system, or rather lack of system, under which we have been brought into the subject, can at least claim that it functioned in the best tradition of natural selection. But clearly one must set some limits to this sort of thing in the interests of efficiency and the saving of time. I would like to make some general observations under this heading.

First of all, what type of man, from the secondary schools, should we welcome as entrants into the biological field? Here I am giving my personal opinion, though I know that many of my colleagues are in agreement with me on this point. We must look here at the kind of training given in the schools.

There was a time, not so long ago, when botany was the only biological subject which found a place in the school curriculum. This applied only to a proportion of schools, and in these it was not on a level with the physical sciences. It was in general a subject for girls and for the weaker of the boys. In the ten years or so before the War there was a considerable change-over from botany to the composite subject biology. This movement was progressive and extended to schools which had not hitherto offered instruction in any biological subject. The expectation is that this development will continue after the War, so that we can look to a not-distant date when biology will take its place as a standard subject in schools, much on a level with physics or chemistry. Considered from the point of view of equipping the ordinary citizen for his life's work, this change has a great deal to recommend it, and I have not met anyone who seriously contests its merits. We are concerned here with the more limited question as to how it affects the equipment of students who go up to the universities bent upon a career in biology.

Frankly, I would say that we would rather that entrants into university biological departments did not have this preliminary biological training at school, and that for two reasons. One of these is probably temporary, the other, I fear, is permanent. As regards the first, we are still in the transition period, which may last for some time. For reasons which are sufficiently obvious, the standard of instruction at present reached varies very greatly from school to school, so that in the mixed batches who go up to the universities it is difficult to know where best we should begin. It is particularly with regard to laboratory instruction that we find the greatest unevenness, and obviously that is very important. No doubt this difficulty will lessen as times goes on. The second objection, of a more lasting nature, is this. Biological instruction in the schools has been developed at the expense of the physical sciences, and there is a grave risk that the biological student of the future will go up with an inferior grounding in these fundamental subjects. Once he has started on his biological work, he may never have the opportunity or the will-power to go back and make good the omission, and so the field of his usefulness may be permanently narrowed. Speaking broadly, one can say that there are some subjects of a kind that if one neglects them in one's

youth, one does not easily pick them up later. Physics, and more especially mathematics, are such subjects.

Summarizing what I have just said, I would picture the desirable type of student somewhat as follows. It is immaterial whether he has had any biological instruction or not, but he should be well founded in the basal sciences, and also have a natural interest in plants or animals. *A priori*, I would rather that he were a countryman who preferred the country to the town, as he would be more likely to feel at home there and to have a broad country background.

The choice of training centre for such a student lies between the biological departments of a university, which nearly always is situated in a large town, and an agricultural college, which is usually in the country. Both have their merits and limitations.

Students at an agricultural college have the advantage that they are not brought up in a theoretical or academic atmosphere, they are in country surroundings and are in contact to some extent with the practical side of things. At the same time I am not prepared to allow that a few years' or even a lifetime's residence at an agricultural college necessarily imparts the true inwardness of the farming life. Many farmers draw a sharp distinction between what is done at an agricultural college and what they consider to be practicable on the average farm. From the technical point of view the great objection to the ordinary agricultural college as a place for the training of specialists in the plant industry is the meagreness of instruction in the basal sciences. A sound and comprehensive course in the biological sciences seems to me to be essential, and that is what the agricultural colleges are not at present in a position to give. Of course, one must allow for exceptional cases, and I know personally some excellent research workers who have graduated by this channel. Nevertheless I consider them to be exceptional cases.

The strength of the university department is the weakness of the agricultural college, and vice versa. I need not dilate upon the social advantages which accompany the university life, but shall confine myself to the technical. It is of the greatest value to a student, in his undergraduate years and perhaps more so during a period of postgraduate research, to be able to rub shoulders with workers in other scientific subjects or in university subjects generally, with consequent broadening of his outlook. There are also the special advantages of access to advanced courses on topics related to his main study, for example, courses on physical chemistry, spectroscopy, and so on. These advantages are obvious, the disadvantages require fuller treatment.

The question has been seriously asked. Is the rarefied atmosphere of a university biological department a suitable training ground for a man who is going to specialize in problems of plant culture? Prof. W. B. Brierley, in his presidential address of some ten years ago to the Association of Applied Biologists, discussed this point in a very lively manner and had much to say about the academic man sickled over with the academic cast of thought. With much of what he said I find that I am in hearty agreement, though I am optimistic enough to believe that there has been an improvement in the interval. I do not think that you will find so many of the academic 'die-hards' flourishing in university circles as you would have found twenty years ago. It is also true that courses in botany and zoology are brought into line with current interests and activities,

by the introduction of new and the scrapping of old material, though it may well be that the process of modernization is not going on fast enough.

Speaking in particular of botanical courses, should say that the greatest weakness is the lack of intimate contact with growing plants. By intimate contact I do not mean merely looking at living plants. I mean actually handling them and growing them. It does not follow from this that I would like to train botanical students as gardeners or farmers, but I do hold that a training which deals largely with preserved plants and which is centred in a laboratory is lop-sided. Every effort should be made to bring the young student, from the earliest stage of his career, into contact with the practical growing of plants. This is desirable for all botanical students but more especially for those who intend to take up an applied side such as plant pathology. Practical contacts can be developed by arranging for students to work at research institutes or on farms during vacation periods, and it is clearly desirable that the facilities in university departments for experimentation in the field or glasshouse should be extended. Granted that such facilities are forthcoming, I feel sure that the proper place for the pregraduate training of the plant specialist, including the plant pathologist, will continue to be the university biological department.

The field of research in plant pathology which is appropriate for a university staff (as contrasted with that of a research institute) is no doubt fairly wide, but there are some obvious limitations, even when the facilities of laboratory and experimental ground are all that could be desired. The subject chosen should be one which could be expected to yield a result within a period of about two years, even though the primary object is not to obtain publishable results as such but to give training in research methods. Two years is a short time for outdoor research, where the kind of work possible is often dictated by the season, and especially when, as often happens, the first season must be largely given over to exploratory work and to the assembling of suitable material. A useful plan in my experience has been to assign to each student two problems, one involving laboratory work and often academic outlook which could be followed up at any time of the year, and the other an outdoor one of a seasonal nature. This has a certain insurance value from the point of view of results, and is particularly useful in helping to tide the student over the earlier slack and sometimes bleak phases of the work.

Teaching and research of the kind which I have been describing, helped by my natural inclination to these matters, have had the effect of bringing me into somewhat close contact with the practical grower and his problems. It happens also that, come of farming stock and am personally acquainted with many farmers and their ways of looking at things. I may therefore be allowed to put down some of my reflexions on the functioning of the research machine, and these will fittingly conclude this address. As there will be some criticisms, I wish to make it clear that henceforth I shall be speaking of plant pathology in the narrow sense where my own experience lies and where I am surer of my ground.

First of all there is the much-debated question of the relative importance of academic and applied research, not merely from the point of view of research as such, but also of research as leading to results of practical value. It has always seemed

e that, in discussions on this topic, much confusion thought has arisen from a more or less unconscious misuse of the rather numerous names which have been applied in this connexion. If we say that there are, broadly speaking, two types of research, the theoretical which aims at understanding phenomena without reference to any practical application of its findings, and the practical which aims at a definite practical result, there will, I think, be general agreement that both are important and desirable, and in many cases there will be found to be an interdependence between the two. Unfortunately it has been customary to apply a superfluity of names to each type of research, and the use of some of these names has led to misconceptions and, in my opinion, to some misdirection of research. Thus, the theoretical type is known as 'academic', 'fundamental', 'basal', 'long-term', and the practical as 'applied', 'ad hoc', 'short-term'. I would like to comment upon some of these terms.

If by 'fundamental' is merely meant 'theoretical' as roughly defined above, I have no objections to it. There is, however, a strong tendency to read a further meaning into the word. Just as a house cannot be built unless its foundations or fundamentals are properly laid, so, it is argued, must the practical work follow and rest upon the earlier fundamental investigation. One hears it freely stated that from such fundamental work results of practical importance drop out from time to time, and all that remains for the practical man is to recognize them as such or to seize upon certain principles, proceeding from which he can readily arrive at practical results. Now I am well aware that there is no great difficulty in furnishing examples in support of such views, more notably in certain physical arts—such as radio-communication—in which the practice has been built upon results which a few years ago were of theoretical interest only. The relation of the biological sciences to agriculture is, however, somewhat different, as I need scarcely enlarge upon. Most of the results of practical value have been obtained by the growers themselves—sometimes by accident—and in such cases the function of agricultural science has been in the main to explain the results, to point out their mutations and sometimes to indicate improvements. It is well to recognize the fact that results of the very greatest practical importance have been obtained in connexion with problems the theoretical basis of which is quite unknown to this day. For example, it has been possible to breed potatoes which to all intents and purposes solve completely the problem of late blight disease, and yet we are still quite ignorant of the theoretical basis of this very valuable result. Similar examples will no doubt occur to everyone.

It must not be thought that, in speaking as I have done, I am disparaging the theoretical type of research. I should be roundly accusing myself if I did so. It is obvious that theoretical research in biology generally, and in plant pathology in particular, has the same status as it has in any other science or form of learning—that it is worthy of being carried on, and carried on vigorously, on its own account. It has cultural value and adds its quota to the progress of civilization. It tends to fill out the general scientific picture, and from the point of view of the research worker himself it helps in many cases, if I may use the phrase, to keep his soul alive. It is, however, idle to maintain that practical results cannot be obtained without theoretical research, and it has always appeared to me that it is

undignified, to use a mild term, to put forward as a justification of theoretical research the possibility that results of practical value may arise from it by accident. No doubt if pursued long enough and with sufficient insight, it may point the way to a solution of all our practical problems, but that date is not yet. The practical method, I feel, must still be to tackle the practical problem with the means at one's disposal, and in so far as difficulties arise to refer these back for closer investigation in the hope that new insight may be obtained. In other words, the practical method should be that of direct attack, with theoretical research harnessed to it for purposes of guidance and further development.

The description 'long-term' as applied to theoretical research is appropriate. I should be happy to see it replaced by 'everlasting', for the more successful a piece of theoretical research proves to be, the more does it suggest further problems. On the other hand, I heartily deplore the tendency to apply the word 'short-term' to applied research. I have no objection to the phrase 'ad hoc', in so far as it means that there is a definite objective; but it is unfortunate that the adjective 'definite' is so often paraphrased to 'limited' and so to 'short-term', which in many cases has come to mean 'two years or thereabouts'—the normal duration of a research scholarship. The definiteness of an objective has no obvious relation to the time required to reach it, and in biological research, especially when its results are sharply conditioned by seasonal factors, it is surprising how long a time is necessary for the proper working out of even a simple problem. If, for example, it be the matter of the use of a fungicide, even when the best form of fungicide and the mode of its application have been settled, a great deal of work remains in testing its efficiency in various situations and over the variety of conditions which arise in a succession of seasons. I do not believe that the time-consuming nature of much applied biological research has been properly appreciated by those responsible for its organization, and to this more than to anything else is to be ascribed the fact that much research has failed to reach the farmer in a form usable by him. I shall refer to this point again.

The inadequate provision for the 'ad hoc' type of research is illustrated in another way. Fundamental research, from its long-term nature, and because it gives no promise of early results, is not the kind of thing which the cultivator could be expected to subsidize. It must rely therefore upon official support, and examples of reasonable support for it are familiar to all. On the other hand, it has often been expected that for work of the 'ad hoc' type, the industry concerned should pay a substantial share of the cost. This would seem on the face of it to be a reasonable arrangement, and it has in fact functioned, but there are inherent difficulties. Perhaps I can illustrate this point by an experience of my own. When an investigation of the carnation wilt problem had been in progress for two years, support for its continuation was sought from the carnation growers. Very naturally the lead was taken by certain members whose nurseries were at the time being seriously ravaged by the disease. Others, however, were as yet untouched and therefore not so interested. It was freely hinted that the trouble might not be a bad thing in itself, as tending to prevent overproduction and to weed out the inferior growers. Later, it may be added, the disease spread to other nurseries so that some growers had to change their

opinions. One grower said that he knew of a cure, and another that he did not propose to subscribe, but that he would pay for the cure when found. It so happened that there was present a man of very great importance in the industry who took the line that though his firm was not as yet seriously troubled by the disease, the industry as a whole was in danger, and it was highly desirable that he should have as much information as possible in advance of its coming. So the scheme came to be supported. I quote this example, not so much to illustrate how vexatious and chancy the initiation of research in this way may be, but to stress the fact that the financial interests of the growers of any one commodity are not necessarily identical.

Perhaps I should indicate here what, in my view, is the solution of this problem. The effect of the successful application of research to a problem of plant production is that the yield of produce of a certain quality is increased. This might lead either to a reduction in cost to the public, that is, to a raising of the standard of living, or to a reduction in the amount of land necessary for growing the required amount of produce, an economy which is obviously desirable in a small country such as Great Britain. In either event the advantage is national, and therefore the responsibility for initiating and supporting such *ad hoc* work should rest upon national funds, even though some growers may benefit, temporarily or permanently, from the results obtained.

I am hopeful that in the near future we shall see some improvements in the organization of plant pathological research. Hitherto, except for a few cultivations such as fruit, applied research has been of a very occasional and scattered nature. There has been little co-ordination, and, so far as I can see, a lack of purposefulness in following up the 'worth-while' problems to a stage where the results could be confidently brought to the notice of cultivators. It is the function of no one in particular to collate the work which has been done on a particular problem and to devise steps for carrying it forward to a practical solution. When such a survey is made, I am afraid that it will reveal a scarcity of practical methods of proved value, for the conditions under which much research has been done have been such as to limit its scope to purely mycological phases. I am not being facetious when I suggest that this state of affairs is reflected in the *abundance* of control measures which figure in plant pathological textbooks. I am quite certain that many of the methods put forward are of doubtful practicability or usefulness, and that very few have been worked out in a manner which would convince a practical man.

The number of problems awaiting a practical solution is so great that a rigorous selection would be necessary to allow of adequate attention being paid to those deemed most important. What we require is a 'priority list' of problems, and when such a list is drawn up, I hope that the views of research workers and growers will be sought more freely than has been the case in the past.

The practical aim of plant pathological research is not to study plant disease as such, but to point the way to growing good plants in spite of a liability to disease. It seems obvious, therefore, that research should be organized on a crop basis. There must be research institutes for the main crop plants, with small and possibly movable field stations where the more local problems can be investigated on the spot.

We have moved some distance in this direction and I think there will be a fuller development in the no distant future.

As regards the connecting link between research worker and grower, I speak mainly as a spectator. There is just one point which I wish to make in this connexion.

It has often been stated that research workers have in their possession a mass of information which the growers do not put to practical use, either because it is not brought to their notice at all, or if so, not in a form which they can understand. The blame for this tends to be laid upon the advisory organization. I would like to record what has been a frequent experience of mine when visiting nurseries in the Reading Province in company of the advisory mycologist. The object of the visit might relate to one particular problem, but by the time we had gone half-way round the nursery a dozen other queries had been put. There was obviously a multitude of problems, to many of which it was impossible to give a definite answer. Sometimes one could say that "Somebody in America had described a thing rather similar". The plain fact is that there are many growers' problems—of all kinds and dimensions—to which no clear answer can be given, because the necessary research work has not been done. This is a point which I have already stressed. Doubtless the advisory services could be made to function more efficiently—for example, by arranging better facilities for the demonstration of approved methods of culture—but I feel sure that, in the plant pathological field at least, the main lack is in the paucity of appropriate research, and not in the inability of the advisory services to convey such useful information as exists.

To sum up—there is no doubt as to the desirability and feasibility of tightening up our methods of training students for applied biological work, both in their undergraduate years and in their training as research workers, but I feel certain that the greatest requirement is a well-directed concentration upon the problems which the practical grower is prepared to put before the scientific worker. There are many such, and if, as appears to be very likely, there is to be a continued intensification of agriculture in Great Britain, there will be many more in the future. There is no doubt, therefore, as to the magnitude of the field and it is a responsibility devolving upon us, as scientific workers, to show that the practical problems of plant cultivation can be solved by the methodical application of the scientific method.

PSYCHOLOGICAL IMPLICATIONS OF THE CULTURE-PATTERN THEORY

AT the meeting of the British Psychological Society during April 5-10 in Exeter, a symposium was held on "Psychological Implications of the Culture Pattern Theory". The speakers were Lieut.-Colonel R. F. Barbour, Dr J. C. Flugel and Prof T. H. Pear.

Prof Pear opened by remarking that Rut Benedict's "Patterns of Culture" was now ten years old, it had affected some writers upon psychology who use the concept, but few attempts have been made to appraise the numerous psychological implications in the writings of Benedict, Margaret Mead, Bateson, Maslow and Clyde Kluckhohn in the

United States Perhaps on this side of the Atlantic, J H Waddington's "The Scientific Attitude" and O W Brogan's "The English People" can also be regarded as offering, consciously or unconsciously, many examples of 'culture-patterns'.

The theory may help to reconcile certain conflicting opinions in sociology, ethnology, psychology and economics. It maintains that the customs, institutions and dogmas of a culture are woven into a more or less coherent 'pattern'. Every society utilizes only a certain selection of the motives to which men may respond and the goals towards which their behaviour may be directed. The particular selection that any one society employs may be said to give it its characteristic 'pattern'.

Of 'culture', Kluckhohn offers this working concept: "all those historically created designs for living, explicit and implicit, rational, irrational and non-rational, which exist at any given time as potential guides for the behaviour of man." Linton's distinction between explicit and implicit culture is useful here.

Explicit culture comprises "all features of a group design for living which might be described to an outsider by participants in the culture". It includes not only external objects but also manifestations of feeling and thought. An observer ignorant of cricket could describe its apparatus, as well as the fact that the interruption of an exciting innings by the tea-interval is taken for granted by English, and puzzles or infuriates American, spectators. Implicit culture is "that sector of which members of the group are unaware or minimally aware". An MCC member might deem it unnecessary even to justify the tea-interval. Assumptions underlying the present ways of staffing the Foreign Office, or of granting army commissions fifty years ago, are unlikely to be stated easily by those who have always taken them for granted.

Kluckhohn defines two kinds of *patterns*, which he distinguishes from *configurations*. The *ideal pattern*, if described, conveys an idea of what, in a defined situation, people would do or say if they conformed completely to ideals accepted in the culture. For example, in stating the pattern "more than three persons waiting for a bus form a queue", the degree of deviation of actual cases of relevant behaviour from the ideal may not matter. But in a *behavioural pattern* attention is focused upon some mode of what people in fact do. The concepts are to some extent mutually dependent. Some criticism directed against Ruth Benedict's book is based upon the premise that she is writing about behavioural patterns. It is objected that she has not counted cases to establish statistical norms of behaviour, and has neglected material which does not fit her leading ideas. But, says Kluckhohn, 'she is not so much interested in an inductive analysis of how the Zuni, for example, do behave in fact, as in suggesting a relationship between accepted standards of behaviour in Zuni (ideal pattern) and cultural configurations of which the Zuni are largely unconscious'. A *configuration* is a concept of a higher order of abstraction than a pattern. Configurations are Sapir's "unconscious systems of meaning" and Benedict's "unconscious canons of choice".

A pattern is a generalization of behaviour or of ideals for behaviour. A configuration is a generalization from behaviour. Patterns are forms, configurations are interrelations between forms. A pattern can be defined by listing the parts in a determined sequence, and perhaps indicating the duration or

accentuation of each (as in music). A configuration (as in music too) states the principle behind a group of patterns, it is implicit in them and must be inferred out. Into Benedict's scheme, says Kluckhohn, even ideal patterns enter less than do configurations. She comes nearer to dealing with the 'whyness' than the 'whatness' of a culture. When she designates both types of pattern and more than one type of configuration by the same term she invites confusion.

Illustrations of the above concepts were given by Prof Pear. The Christian religion (Protestant and Catholic) shows behavioural patterns, ideal patterns and different, sometimes conflicting, configurations. The relative mildness of class enmity in England may be due to the fact that many important configurations, for example, 'fair play', respect for personalities, are common to different social strata and that others which are not, conflict less violently than in many other countries. He suggested that the culture-pattern theory, perhaps with these modifications, illuminates the following developments in psychology (among others):

Psychological provincialism Some psychologists have tried to build up 'the science of behaviour of the normal adult' upon the basis of observations and experiments confined very largely to college students in Western cultures. Mass observation and participant observation (functional penetration) have attempted to remedy this.

Some differences between psychological systems in the last fifty years may be due to the different culture patterns in which the authors grew up and lived. Examples given were James, Watson, McDougall, Freud, Jung and Adler.

The theory seems compatible with Prof Gordon W Allport's concepts of the transformation and functional autonomy of motives, put forward in his "Personality" and other publications.

Personality obviously depends upon culture pattern, and since there may always be with us the two opposed but complementary views of personality, one from the point of view of the 'actor', the other from that of the 'reactor', a study of culture-patterns will illuminate the way in which a judgment of a personality may cast at least as much light upon the judge as upon his 'subject'.

The difference between biological adaptation and mere temporary adjustment to the (often transient) claims of society is understood better by the help of this theory.

To what extent is the modern psychiatrist dependent upon the culture-pattern which 'employs' him? Must his tenets be fundamentally modified if it alters (for example, from a war-like to a peaceful set-up), or if he changes the country in which he works? To what extent does a psychiatrist on joining the combatant forces in any country accept the patterns and configurations of the new temporary 'culture'? How far do sentiments, ideals and purposes similar to those in the Allied armies actuate German army psychiatrists? Are their motives essentially different, and/or are they woven into a different 'pattern'? Would German army psychiatrists, for example, concur in certain English or American diagnoses of Hitler's mentality made *in absentia* and at a range of six hundred miles? To what extent are these diagnoses absolute or relative to certain postulated social norms?

Does a psychiatrist's own social, economic, religious, moral, political conditioning affect his

attitude towards a psychoneurotic (a) civilian, (b) soldier? Are some psychoses merely culturally defined, setting problems merely in social pathology? Are some psychoses constant all over the world?

May the success of the physical sciences have brought about a 'scientific attitude', which itself symbolizes a powerful culture-pattern? Is this in its turn now changing from respect for 'science' and its postulated 'freedom' (among educated people) to an overt opposition between this attitude, or sentiment, and one of doubt whether after two wars which men of science have made more deadly (perhaps made possible) the average individual scientific worker can any longer be blindly trusted to choose his problems? Nazi 'medical' investigators have betrayed humanity's trust in them. Can the ordinary man be blamed for reluctance to believe in the humanitarian bent of a man of science, merely because he calls himself by that name? (The broadcast discussion between Bertrand Russell and J. B. S. Haldane on May 4 (*Listener*, May 16, 1945) mirrors a clash of contemporary culture-pattern.)

Dr J. C. Flugel pointed out that the distinctions between behavioural patterns, ideal patterns and configurations, though useful and important, are not clear-cut, and shade into one another. They all involve a greater amount of inferential supplementation than do perceptual *Gestalten*. As with the latter, we must beware of confusing the subjective pattern itself with the reality underlying it. There are two problems, one purely psychological. "How does the pattern arise in the observer's mind?" and one metaphysical. "How far does the apprehended pattern (usually no more than an interconnected set of 'generalizations') correspond to actual fact?" In the latter problem we are confronted with the same tasks as those connected with the validation, and interpretation when validated, of hypothetical 'types' or 'factors'. The doctrine of culture-patterns is made more difficult by the fact that, especially in complex societies, the various patterns that can be distinguished (of group, locality or time and of varying degrees of inclusiveness) have complicated inter-relations. This may in practice greatly reduce the utility of 'patterns' as instruments of scientific thought.

Nevertheless the doctrine is valuable, as emphasizing social, contrasted with biological, explanations, as stressing the interrelations of the different elements of a culture, as producing useful working hypotheses and as raising many important problems (for example, its apparent opposition to the doctrine of 'archetypes', to psycho-analytic interpretations of culture and to the whole trend of thought of the 'classical' school of Tylor, Frazer, etc., as well as to the assumptions underlying the more recent work of J. D. Unwin).

Lieut. Colonel Barbour mentioned as a smaller but equally important problem, 'professional patterns'. Of the following he had had recent personal experience—boot operatives, hairdressers, psychiatrists. He asked whether psychologists tend to conform to some dynamic personal pattern. Is it easier for them to perceive the truth if it lies in one direction rather than in another? What is the bias of the observing, dissecting, enumerating mind?

Psychiatric diseases are still in the main defined in terms of inadequate performance of a human being *vis-à-vis* other human beings. In this War, psychiatrists when working as selection officers have developed a technique quite different from the

clinical interview, where the medical man tends to be an inquiring, almost aggressive figure. In selection, he has to be more passive and receptive. He substitutes for the negative aim of discovering discords the positive one of evaluating all sides of the personality.

Being conscripted into the Services involves for most men and women what is tantamount to a change of culture, exchanging a personally determined, family-oriented existence for a regimented community life, lacking in privacy and comfort, with increased risks to health and life. He described how these changes of cultural environment affect the psychotics, the mental defectives, the psychopathic personalities, the psycho-somatics and the neurotics respectively. The battle incidents which precipitate many of the neuroses are horrifying only to our culture, but are a few phenomena, for example, the faint, symbolic of something more primitive, more remote?

Benedict stresses that culture need not be essentially repressive. Yet every society has its outcasts. It is culture which decides that a difference is a disability. In the last thirty years in England there has been a steady growth of the province of illness at the expense of that of ethics. Recidivism, sexual perversions, cowardice are now quite as likely to be looked on as evidence of illness as of criminality. It is a sign of the times—or of our culture—to send for the doctor or for the psychiatrist, where a generation ago the priest would have been called in. This is a change, possibly an advance, yet in another culture the teacher or politician might be consulted.

Lieut. Colonel Barbour concluded. "It is particularly appropriate that this symposium should be held at this time. During the last twenty-five years we have seen the rise of Nazism and a new phase of national development in Russia. It makes me hopeful of this country, as we too can change our culture if we so wish. But we must scrutinize very carefully what appear to be some dominant trends of our time, among them the evading of individual responsibility, a softness of outlook which seems to expect life to be free, even of growing pains, a preference for compromise rather than for co-operation."

¹ Summarized in "Are There Human Instincts?" by T. H. Pear, *Bull. John Rylands Library*, Manchester, 27, No. 1 (Dec. 1942).

X-RAYS AND CELLS

By DR. P. C. KOLLER
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THIS year marks the centenary of the birth of Roentgen, who announced the discovery of X-rays to the Physico-Medical Society of Würzburg fifty years ago (1895). The importance of X-rays for diagnosis in medicine was quickly realized, but their use in treatment, owing to technical difficulties, began only after the discovery of radium three years later. First radium was found to check the growth of tumours in mice¹, then X-rays were found to check mitosis in roots and pollen², early discoveries, which form the remote foundation of modern radiotherapy, or radiation treatment. Later, Strangeways and his colleagues^{3,4} showed that different doses had different kinds of effects on tissue cultures.

Yet while the evolution of radiotherapy was analytical on its physical side⁵, on its biological side it remained empirical, for little or nothing was known

the way in which radiation exerted its influence on cells and tissues. To provide the required information many experiments have been and are being carried out on the 'biological effects of radiation', a phrase which seems to claim too much for data which tell little. Such diverse 'biological indicators' have been used as bacteria, infusoria, yeast and mould, corn and pondweed⁶, pollen, seed, root and stem of bean and onion, egg, sperm and larva of fly⁷ and arfish⁸, toe and heart of frog⁹, caterpillars and salamander, sperm of ram, blood of mouse, eye of cat¹⁰, and skin of man, indeed, a regular witch's brew.

The dose varied as much as the material, from 2.5 to 200,000 r. The results varied even more, often to the despair of the experimenters. This confusion and contradiction of data can easily be explained, for most of the effects measured and compared are not so immediate and initial effects but the end-products of a chain of reactions set in motion by the radiation. The length and complexity of these chains are unknown. While the effects induced were striking, owing no doubt to the too high doses of radiation used, their complexity made an analysis of their origin extremely difficult if not impossible. From many experiments on the biological effects of radiation two general conclusions were reached: that the effects were on the nucleus, and that their expression was delayed.

A new insight became possible with the discovery that radiation induces gene mutation¹¹ and breaks in the chromosomes¹². Investigations by Muller¹³ and Hers^{14,15}, using the sperm of *Drosophila*, showed a quantitative relationship between single ionizations of the chromosomes and the changes they induce. The analysis of the end-results of two such changes, even as chromosome rearrangements, in the giant parter-millimetre chromosomes of the salivary glands of *Drosophila* gave brilliant results¹⁶. But this success was limited by the fact that the structural changes were available for analysis only in the generation derived from X-rayed sperms, and these changes represent only a small fraction of those originally induced. Cytologists thereupon turned their attention to the direct study of X-rayed cells.

The advantage of their study is that the different changes in the chromosomes can be seen a few hours after treatment and the method of their origin can therefore be inferred. During the last eight years a great body of data has been obtained by Sax¹⁷, Hatcheside¹⁸ and others using pollen-grains—single cells, which are also individuals with a fixed cycle of development. This new work confirmed the first principles established by Stadler¹⁹ and Mather and Stone²⁰, that breakage and reunion were separate events and that breakages were of two orders—chromosome and chromatid—and the time the chromosomes split in the resting nucleus thereby established. Koller²¹ showed that the death of the cell was the result not of direct action by X-rays but

loss of chromosome fragments at the ensuing mitosis. Again, however, it soon became evident that the interpretations of different workers were inconsistent. This could be attributed partly to differences in interpretation of the induced chromosome changes and partly to inherent shortcomings in experimental design. Most of the cytological analyses of the radiation-induced changes disregarded the enormous variation in breakability of chromosomes during the nuclear cycle and the great differences in rate of development of cells within any sample. Besides these two, lack of temperature

control—which characterizes most cytological analyses—introduced a third error. Furthermore, the two most important events, breakage and reunion of broken chromosomes, although known to be separate events, have not been separated. The situation, indeed, sometimes showed signs of approaching insolubility, though concealed with higher mathematics.

A fresh approach to this problem is made by Darlington and La Cour²² based on an analysis of spontaneous chromosome changes²³. Their methods are new in several respects. Radiation effects are analysed in samples of complete cells in complete developmental series—root-tips, pollen grains and pollen tubes with resting stages lasting from a few hours up to 195 days. The breakage and reunion of chromosomes are recorded separately. Doses as low as 5 r and up to 360 r are used over a wide range of controlled temperatures. The statistical analysis, to which Mather has contributed, proceeds from frequencies to coefficients and correlations both new and unexpected. One simple example will show how these methods have brought order out of confusion. For many years it has been a moot point whether chromosome aberrations varied proportionately to, or according to some other power of, dose, and if the latter whether with a 1.5 power or with the square or with some other exponent. Now Darlington and La Cour have shown that breaks vary directly with dose, taking an average of total cell samples. Reunion of broken chromosome ends, on the other hand, varies with breakage, taking not whole cell samples but cells in classes with different numbers of breaks. One realizes, therefore, the hopelessness of the previous search for simple numerical formulae.

These new methods of Darlington and La Cour seem to have been successful in separating the nuclear and cytoplasmic effects and in showing their interactions. The main conclusions reached are: (a) that breakability and rejoinability of the chromosomes are negatively correlated, (b) that variation in both depends on the activity of the cell and on the heterochromatic content of the nucleus. These correlations lead the authors to assume a common denominator in the three classes of effects—breakage, reunion, and sister reunion of chromosomes and chromatids. So much they seem to have proved, whether they are justified in supposing that this common denominator is the nucleic acid charge on the chromosomes further studies will show.

There is an interesting analogy between the primary effects of low-dose irradiation as described by Darlington and La Cour and the characteristic abnormal mitosis in tumours²⁴. Both show a prophase hastened (not, as other workers have said, retarded); an excess of ribose nucleic acid in the cytoplasm²⁵; and an excess of unpolymerized or sticky desoxyribose nucleic acid on the chromosomes²⁶.

Darlington and La Cour's results confirm some of the principles deduced from previous experiments. They seriously conflict with others for reasons which their new data make clear. They prove that irradiation, as well as temperature, affects the time-scale of development by which we have to measure its action in the breakage of chromosomes. This explains clearly why single-time comparisons of radiation effects (often with uncontrolled temperatures and incomplete recording) have hitherto shown discordant results. Their results show also the complexity of cell-response to radiation, which, however, can be revealed and analysed by the methods used.

Apart from the theoretical conclusions which Darlington and La Cour arrive at, their method of analysis (which they amply illustrate) will now enable us to investigate and to compare the effects of radiations of different wave-lengths (X- and gamma-rays, neutrons and alpha-particles), and that of different dosage-rates, all of which are of great importance in the development of radiotherapy. The misgiving has often been felt, and quite recently expressed in *Nature* by a physicist²⁷, "that there is an uncertainty about the action of X-rays which is very tantalizing. Complete success appears to be so near and yet continues to elude us". We now have, if not success, at least the prospect of success. The experiments of Darlington and La Cour give not only a new impetus to the study of the biological effects of radiation, but also a new foundation.

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THE BELGIAN NATIONAL FUND FOR SCIENTIFIC RESEARCH

By JEAN WILLEMS, C B E

Director of the National Fund for Scientific Research

ON October 1, 1927, King Albert spoke on the occasion of the 110th anniversary of the creation of the Cockerill Works at Seraing, at the very centre of the industrial district of Liège. "Nations," he declared, "which neglect science and scientific men are marked for decadence. Considerable and sustained efforts must be made, there must be more initiative if we wish—as we must wish—to maintain our position and our reputation. To-day, those who do not go forwards go backwards."

This speech was made less than ten years after the conclusion of the War of 1914-18, when the "Fondation Universitaire", as well as the funds of the various Belgian universities, had been richly endowed, following the winding up of the Commission for Relief in Belgium and of its Belgian counterpart, the "Comité National de Secours et d'Alimentation"

It emphasizes the pressing demands made by science and the continual expenditure which has to be faced for the maintenance of intellectual standards. King Albert's urgent appeal received a generous response and three months later public subscription had provided Belgium with 115,000,000 francs. This led to the creation, on April 27, 1928, of the "National Fund for Scientific Research", which aimed at intensifying scientific activities, and at placing research workers and scientific men in such a position that they could play a worthy part in the moral and material development of the country.

The new institution benefited immediately from the active co-operation of the most eminent representatives of the academic world. Its programme of activities included all questions which had necessitated and justified its creation, and it soon appeared that the measures adopted justified the highest hopes. At first, however, the National Fund was scarcely known outside Belgium. It suddenly came to general notice when it assumed responsibility for a perilous venture which was eagerly followed all over the world. This was the first stratospheric ascent by Prof Piccard. Within three days, this man of science achieved popular renown. Homage was paid to him at a scientific meeting, when Prof Bordet himself a Nobel prizewinner, said "Your exploit which has thrilled men of science, has gone straight to the heart of the people. They are filled with admiration when they see a man of your intellectual power championing the cause of science with the courage of a hero."

The National Fund was applauded for its share in this work, which proved its desire to promote active international science.

This favourable impression was confirmed by the archaeological excavations pursued at Apamea. One of the immense porticos which stood above the highway of this wealthy Syrian city, once a rival of Antioch, was partially reconstructed. Apamea was plundered and burned by the Persians in the seventh century B.C., but the discoveries made among its ruins have revealed original works of art and architecture, and particularly wonderful mosaics. The remains, now in the museums of Brussels, enable us to recapture some of the features of the ancient Persian and Roman town. The names of the Belgian historians and archaeologists, Henri Pirenne, Franz Cumont and Fernand Mayence, are associated in this fine work.

Equally valuable results of another expedition supported by the National Fund are also gathered together in the Brussels Museums of Art and History. The expedition went to Easter Island, in the Pacific Ocean, and investigated the enormous statues carved in the rock, reaching heights of 6-30 ft., and weighing up to 40 tons. A Franco-Belgian mission, including M. Henri Lavachery, now keeper of the Royal Museums of Art and History, undertook the journey and succeeded in gathering valuable information on a most interesting problem. This was to discover whether the writing known by the natives of the island in the fourteenth or fifteenth century could be identified with that shown on slabs discovered in India, and dating as far back as 2,500 B.C. From this it was hoped to ascertain whether Easter Island was the remainder of a lost continent and of a rich civilization since vanished.

Another expedition sponsored by the National Fund was equally successful. Ruwenzori had first been seen by Stanley in 1888, and since then its east-

slope had been explored several times, the highest summits having been climbed for the first time in 1906 by the Duke of Abruzzi. But the western slope had remained unexplored. This part of the mountain lies within the boundary of the Belgian Congo, and the Belgian mission undertook to study methodically its geology, flora and fauna. Thanks to their skill and endurance, the expedition gathered much information, and hoisted the Belgian flag at an altitude of 15,000 ft.

About the same time other men tackled, with great devotion, a problem which combined scientific and humanitarian interests. For a long time, Belgian missionaries had pursued their work in certain parts of China. One of them, the Rev. Father Rutten, returned to that country accompanied by two medical men, and undertook long journeys to vaccinate missionaries. Their aim was first to check, in endemic conditions, the preventive methods advocated by Dr. Weigl, the Polish man of science, and secondly to test the curative value of a serum in cases of exanthematic typhus. The results obtained are well known, whereas in former years the Belgian community of Scheut lost a number of missionaries, no case of disease was recorded after vaccination, but the same mortality prevailed in the missions where vaccination had not taken place. These results were published by the French bacteriologist, Charles Nicolle, and by Prof. Bruynoghe, of the University of Louvain.

Belgium also took part in the organization of the International Polar Year (1932-33). Ever since 1882-83 the idea had been mooted of active co-operation of scientific workers belonging to various countries in order to bring more unity and co-ordination into the work of polar expeditions. The programme of the second Polar Year, prepared a long time ahead in the course of international conferences, included a great number of subjects: the meteorology and explorations of the atmosphere, the dynamics of cyclones and anti-cyclones, weather forecasts, terrestrial magnetism and atmospheric electricity, earth currents and the aurora polaris.

Under the auspices of the Government and of the National Fund, Belgium undertook to establish a new magnetic station in the province of Liège and another in the Belgian Congo. These stations carried on observations, following the plans elaborated by the Polar Year Commission. The president, Prof. La Cour, director of the Copenhagen Observatory, paid tribute on several occasions to the part played by Belgian scientific workers in the common effort.

A few other examples of the activities of the National Fund can only be mentioned: participation in the new scientific station established on the Jungfrauoch, in the work of the Commission of New Analytical Reactions and Reactives, created by the International Union of Chemistry, in the works of the International Office for the Protection of Nature.

Then came the War and the German occupation. The country was separated from the civilized world and endured with great courage and devotion the oppression and sufferings of this cruel ordeal. Her men of science and research workers resisted to the end. When one university was closed by the occupying Power, other universities and institutions received its professors and students. When one institution lacked some product or apparatus, other institutions gave them or lent them. When some professors or academic authorities were arrested or dismissed, their

colleagues filled the gap. Without publicity, the National Fund applied itself to the task of helping, promising young men of science and research workers and of solving questions arising from war conditions such as the scarcity of food, and the protection of the unique stained glass windows of the Church of St. Gudule in Brussels. It has also prepared the ground for attacking post-war problems, within the framework of its traditions. All this necessitates inroads on available resources, and great tenacity in spite of unfavourable and often hostile surroundings.

To-day Belgian scientific workers are once more free to speak and act according to their scientific conscience. Contacts have already been established with their foreign colleagues, publications have been exchanged, and visits abroad are being planned. The joy derived from this release can only be appreciated by those who have for years been 'in prison' in an occupied country. We are beginning to hear of the eminent part played by men of science during the War. They will work to-morrow with the same zeal to further the material and moral reconstruction of the world. The National Fund for Scientific Research will continue to support Belgium in the part she is going to play in this great work.

OBITUARIES

The Right Hon. the Earl of Onslow, P.C., G.B.E.

LORD ONSLOW died, after a long illness, on June last. He was a man of many parts, many corresponding activities and many friends, who were attracted to him by his own native friendliness and the affectionate simplicity and sincerity of his disposition. His many public services, in the course of which he left his mark especially on the day-to-day administration of local government, are a matter of record. He rendered other services which are perhaps, less widely recognized, though, regarded in their true perspective and in the light of the fruits they may be expected to bear hereafter, they may prove to be the most important of them all.

A sportsman, and, like most of that fraternity, field-naturalist, Lord Onslow became, as a matter of course, a fellow of the Zoological Society, and, after many years of useful service on the Council, was elected president in 1936 as the obvious successor to the late Duke of Bedford. To this new task he brought the high sense of duty and the unflinching industry which characterized all his undertakings. He had, already, in 1926, been chosen as president of the Society for the Preservation of the Fauna of the Empire. In this post he was in his element, and it was here that he did what may well prove to have been the most enduring and most valuable work of all. To him the preservation of wild life meant the preservation of the beautiful and interesting thing the contemplation of which above all makes human life worth living. He recognized as few others did that man, "a little lower than the angels", was also only a little higher than the rest of the world ecology of which he is a part, and incomplete if divorced from that ecology. Further, he recognized that though man could destroy, and was, on balance, destructive rather than a productive animal, he could not create. If man destroyed a species, it was lost for ever, and man might discover too late that he had done himself irremediable harm, and whether

the damage done by the destruction of a species could be measured economically or not, at least, through his agency, life on this planet had been made less beautiful and less interesting, if not for everybody, at least for many of its human inhabitants.

It may well be that the first seeds of this conviction were sown in Lord Onslow during a period of his early life spent in New Zealand, where his father was Governor, and was one of the first to initiate practical measures to avert the destruction of New Zealand's unique avi-fauna. The indifference of New Zealanders to the marvellous ecology of which they became the trustees by right of settlement always distressed him. Having, as president of the Fauna Society, taken the leading part in securing the adoption of the convention for the Preservation of Wild Life in Africa, he turned eagerly to preparations for a new conference through which he hoped to extend the application of the principles embodied in it to south-east Asia and Australasia. That Conference was to have been held under his presidency in 1939, but the threat of a world war led to its postponement.

Throughout the War, he never lost hope of an active renewal of the campaign for wild-life preservation, which he hoped to see extended ultimately to the whole world. He watched with critical interest the negotiations of the Pan-American Conference in 1940 which led up to the convention for "Nature Protection and Wild Life Preservation in the Western Hemisphere" between the United States and the South American republics. He used unavailingly all the influence he possessed to induce the American States to invite representatives of Canada and other British and European-owned territories in the American Continent to the Conference, and was not a little exasperated by the illogical insularity which led the United States and the rest to exclude them. Nevertheless, he had the satisfaction of observing that the Convention agreed to follow in essentials the model of the African Convention of which he was the legitimate parent, and he was determined that American observers should be invited, for their better education, to the postponed Conference for south-east Asia and Australasia when summoned after the War. He was keenly interested, also, as was to be expected, in the movement for the establishment of national parks and nature reserves in Britain, and was a most active president of the Society for the Promotion of Nature Reserves.

It may be said of Lord Onslow that he saw the light and, very clearly, the vision which the light revealed. In failing health he never lost interest in the work of the Society for the Preservation of Fauna of the Empire, and probably few events gave him greater pleasure than the presentation to him in November last of the first gold medal of the Society in recognition of his outstanding services to the cause of fauna conservation. It will not be easy to find a torch-bearer to succeed him, one who will feed the flame as he fed it, and bear it blazing bright with the same resolute and lofty inspiration.

HENRY G. MAURICE.

Dr. Hans Przibram

THE obituary column of *The Times* records the death "some time in 1944, at Terezin (Theresienstadt), Czechoslovakia, of Hans Przibram, formerly Professor in the University of Vienna, and his wife Elizabeth Margarethe (née Ruhmann)." Behind these

words lies untold tragedy, for Theresienstadt was one of the worst of the concentration camps, and many thousands of Jews were slaughtered there. The War had not long begun when we heard of the death at Dachau of Prof. M. Siedlecki of Cracow, an old and famous and much-loved naturalist, it is scarcely ended when we hear that Hans Przibram has been done to death, who once was rich, enthusiastic, hospitable, and whose Laboratory, or "Vivarium", was known to every naturalist who came to Vienna. We know of many another, and dread to hear of more, who have suffered from the same ferocious inhumanity.

Hans Przibram began his work about forty years ago, under the influence of Wilhelm Roux, Jacques Loeb and Hans Driesch, in other words, he became a student of experimental zoology. He planned an ambitious work under that title, and brought it out between 1907 and 1914, in five parts, on "Embryogenese", "Regeneration", "Phylogenese", "Vitalitat" and "Function". An early paper of his, on the "Anwendung elementarer Mathematik auf biologische Probleme", appeared in *Roux's Vorträge* in 1908, and fifteen years later he published an "Aufbau mathematischer Biologie", in *Shkuel's Abhandlungen*. Another book of his, published in 1922 after he had become *ausserordentlich* professor of experimental zoology, was entitled "Form und Formel im Tierreiche", or "Beiträge zu einer quantitativen Biologie". It contains many useful numerical data, physiological and morphological, or "biological constants" as he chose to call them. The new science of biometry was after his own heart, and he published various "Messungen und Wachstumsmessungen", chiefly among insects. These measurements, especially those on one of the praying mantids, led him to believe (as Brooks and others had suggested before) that the spurts of growth and successive moults of an insect tended to coincide with a doubling of its weight and (presumably) with a histological duplication of every cell in its body, and further, that the doubling of its weight implied a linear increase from one stage to another in the ratio of $1\sqrt[3]{2}$, or $1\frac{1}{2}6$. The sizes of the successive chambers in a spiral foraminifer should, and do (he said), follow the same law, but the study of the cast skins, or successive moults, of a serpent led to no such result, for no general histological duplication was involved. There was a good deal of truth in all this, but Przibram was apt to go too far, and let his theories outstrip his facts. It is at least clear that he was a keen and early student of that experimental side of zoology which has proved engrossing ever since to many.

Hans had a brother Karl, a distinguished physicist, we have no news of him. He wrote, among other papers, some on the Brownian movement, which I remember attracting Sir J. J. Thomson's attention to when they appeared. One was on the Brownian movement of non-spherical bodies, and another (in *Pflügers Archiv*) on the Brownian movement as indicated in the movements of minute organisms. He also wrote a curious paper on "Form und Geschwindigkeit ein Beitrag zur allgemeine Biologie".

D'ARCY W. THOMPSON.

We regret to announce the death of Lord Eimouth, who during 1897-1911 was a member of the chemical staff at Columbia University, or June 7, aged eighty-two.

NEWS and VIEWS

Award of Bruce Medal to Prof E. A. Milne

THE Bruce Gold Medal, founded in 1897, is unique among astronomical awards in that the responsibility for the nomination of candidates rests with the directors of the Harvard, Lick and Yerkes Observatories in, and the Greenwich and Cordoba Observatories outside, the United States. The consequence has been that the directors of the Astronomical Society of the Pacific, who are the trustees of the Bruce Medal Fund, have always had before them the names of the outstanding astronomers of the time, and so wise has their final choice always been that the Medal is generally recognized as the highest award for astronomical achievement. It is only fitting that the name of Edward Arthur Milne should be added to those of the great mathematical astronomers—Newcomb, Hill, Poincaré, E. W. Brown, Eddington, de Sitter and Charlier—who have achieved this distinction. Milne's contributions have covered a wide field in astrophysics and cosmogony. His studies of radiative equilibrium in stellar atmospheres greatly extended and deepened the classical results of Schwarzschild in this field, while the collaboration of Milne and Fowler in the application of ionization theory led to the generally accepted scale of temperatures and pressures in the stellar sequence. By-products of these two main lines of investigation were a theory of the equilibrium of the solar chromosphere as a result of monochromatic radiation pressure, and the concept of 'run-away atoms' as the carriers of those disturbances in the sun which lead to terrestrial magnetic storms and radio fade-outs.

Milne's recent work has traversed more controversial ground. On one hand, he has dealt with the consequences which flow from the role of photospheric opacity on the internal structure of the stars, and on the other hand with the kinematic aspect of the apparent recession of the extra-galactic nebulae, treated in the first instance as actual motions in a flat Euclidean space. The attempt to introduce dynamics and gravitation into this concept of world-structure has led to the distinction between the finite t -time by which the observer on a 'fundamental particle' describes events, and the τ -time with an infinite past with which events may be described in a public hyperbolic space. No matter what the ultimate success of these later ventures, there can be no doubt of the clarification in our ideas which has already resulted from his work, or of the courage which this single-handed attack upon these great problems must have demanded. The award of the Bruce Medal is therefore but a fitting recognition of Prof Milne's great contributions to our knowledge of the stars, and of that larger system of which the stars form a part.

Guthrie Lecture of the Physical Society:

Prof. Arturo Duperier

THE Guthrie Lecture of the Physical Society will this year be given by Prof Arturo Duperier on July 6 at the Royal Institution, his subject being "The Geophysical Aspect of Cosmic Rays". As research professor in the Instituto Nacional de Física y Química (Rockefeller Foundation), Madrid, Dr Duperier made experimental studies in magnetism in association with his former teacher, Prof Cabrera. Later, in 1932, he was appointed professor of geo-

physics at the University of Madrid. His geophysical researches included studies on meteorology, atmospheric electricity and cosmic radiation, papers on these subjects were published during the Civil War, in the course of which he paid two visits to Great Britain, the victory of Franco occurred during his second visit, and he has since lived and worked here. In association with Prof P. M. S. Blackett he continued observational work on cosmic rays at Manchester, with the aid of a research grant from the Royal Society, later he transferred his apparatus to the Physics Department of the Imperial College, London, where he has worked for several years. His observational discoveries include remarkable occasional changes of cosmic-ray intensity associated with geomagnetic storms.

British Coal Utilisation Research Association:

Prof. D. T. A. Townend

PROF D. T. A. TOWNEND, Livesey professor of coal, gas and fuel industries at the University of Leeds, has been appointed director of the British Coal Utilisation Research Association. Educated at Bancrofts School, Prof Townend held an exhibition at the East London (now Queen Mary) College, where, after war service, he graduated in 1920. Following post-graduate study in fuel and chemical engineering at the Imperial College of Science and Technology, he was associated there for many years with the late Prof W. A. Bone and Prof D. M. Newitt in investigations into combustion and high-pressure problems, and held successively a Salters research fellowship and a Rockefeller international research fellowship. He is a leading author in the field of combustion, and in 1933 discovered the two-stage ignition phenomenon of higher hydrocarbons, etc. The Livesey chair which Prof Townend has occupied for seven years was endowed by the gas industry in 1910, since when the Department has collaborated closely in research with this industry. Prof Townend has served on the Council of the Gas Research Board since its inception in 1939 and is an honorary member of the Institution of Gas Engineers, he is also chairman of the Yorkshire Section of the Institute of Fuel. During the War he has served on a number of Government committees and his Department has made notable contributions to the war effort.

Visit of Prof. A. V. Hill to Denmark and Norway

PROF A. V. HILL, senior secretary of the Royal Society, is visiting Copenhagen to convey the greetings of the Royal Society, as representing the men of science of Great Britain, to their colleagues in Denmark, and through the Academy of Sciences in that country to discuss with them what aid British science can give to the rehabilitation of science and scientific education in their country. After three days in Copenhagen, Prof Hill will proceed to Oslo for the same purpose. An extraordinary meeting of the Norwegian Academy of Sciences has been called to meet him. It is hoped that these visits will do much to enable both the Danes and Norwegians to re-establish the firm scientific contacts which, until the occupation of their countries by the Nazis, they have always maintained with men of science throughout the world.

Destruction of Scientific Institutes in the Philippines

INFORMATION has been received that the buildings of the Bureau of Science, Manila, have been utterly destroyed in the fighting for that city, and, moreover, it is reported that the Japanese have destroyed the Philippine College of Agriculture at Los Banos, eastward of Manila. The loss of the scientific collections and libraries in the Bureau of Science is irreparable. The Bureau took shape in January 1906 by the union of the Bureau of Government Laboratories and Mines, and was charged with investigations in bacteriology, immunity, prophylaxis, etiology, botany, various branches of zoology (in particular entomology), technological chemistry, geology and mining engineering. The whole structure has gone—the records of the work of forty years, for the two Bureaux named had been at work for four years before the Bureau of Science was formed.

Botany has been singularly hard hit and singularly ill-fated in the Philippines. The collections which Sebastian Vidal made when he was inspector of forests towards the end of the Spanish regime were lost in an accidental fire in 1897, and those of the Augustinian Friars burned when the Guadalupe Monastery was destroyed in the fighting in 1899, in consequence of this, Dr E D Merrill, who went to Manila in 1902 as Government botanist, had to begin his work without foundations on the spot. He gathered together a herbarium unique in its facilities for study of Philippine botany and a botanical library second to none in Asia. These have gone. His four-volumed "Enumeration of Philippine Flowering Plants" (1922–26) preserves a part of the records, but beyond collections from the islands, the herbarium held a great amount of comparable material from all parts of the East.

Spectroscopically Standardized Substances

As the use of the spectrograph for the detection and determination of the metallic elements in all kinds of materials increased, there arose a demand for extremely pure metals, oxides and salts to serve as standards. About 1922 Dr S Judd Lewis suggested to Messrs. Adam Hilger, Ltd., that they should supply for this purpose spectroscopically standardized substances, the proposal was adopted, all arrangements for the supply of the substances and their analysis being in the hands of Dr Judd Lewis. These pure substances have become well known under the trade mark of "H. S." Substances, and now include most of the more common and many of the rarer metals, as well as most of the rare earth oxides. In 1932, when Dr Judd Lewis proposed the 'ratio quantitative' method of spectrographic analysis, the 'Specpure' series of 'ratio powders', 'ratio solutions' and pure salts was introduced, and now comprises more than fifty substances which are available in a spectrographically standardized condition. Every supply of "H. S." or "Specpure" material has always been accompanied by a full report of the results of chemical and spectrographic examinations made on that material. So far as possible, an estimate is given of the amounts of each trace element present, and reference is made to all the spectrum lines due to the impurities which have been detected.

In view of the ever-increasing demands for the substances included in these two schemes and for new additions to the list, the need arose for additional manufacturing and analytical facilities. Messrs

Adam Hilger, Ltd., have therefore entered into an agreement with Messrs Johnson, Matthey and Co., Ltd., whereby the latter will in future undertake the supply of these substances and the control of their purity at their Research Laboratories, Wembley, Middlesex, where many of them will be made. Dr Judd Lewis, who acted as consultant for Adam Hilger, Ltd., for many years and was chiefly responsible for the development of the "H. S." and "Specpure" schemes, has been engaged in that capacity by Messrs Johnson, Matthey and Co., Ltd., and the staff of the Spectrographic Department of their Laboratories has been augmented by the appointment of Mr D M Smith, formerly in charge of spectrographic investigations at the British Non-Ferrous Metals Research Association. Future sales of "H. S." and "Specpure" substances will be made only by Messrs Johnson, Matthey and Co., Ltd., from their head office at 73–83 Hatton Garden, London, E C 1.

Official Topographic Maps

OFFICIAL large-scale maps are available for comparatively few parts of the world outside western and central Europe, including the British Isles, the eastern United States, India, much of Burma, several of the Netherlands East Indies and Japan. South America, Africa and Australia each have few areas of such detailed survey. In the April number of the *Geographical Review*, a coloured world map on a scale of 1 to 50,000,000 compiled by R R Platt shows the distribution of official topographic maps as available at the outbreak of war in 1939. It covers scales up to and including 1:253,440 (4 miles to 1 in). Three categories are recognized, scales of 1 mile to 1 in. or larger, those of 1–2 miles to 1 in. and those of less than 2 miles down to 4 miles. Under each category an attempt has been made to distinguish between maps based on topographic survey on which relief is shown by contours or hachures, and maps of less complete detail with relief shown by form lines or hill shading. As a general rule, only maps produced by States for their own territory are shown, but there are some few exceptions. Compilations produced by an official agency of one country in the territory of another are not shown.

Russian Papers on Pure and Applied Mathematics

AMONG Russian periodicals and books recently received are several containing papers on pure and applied mathematics. A striking feature is the many investigations of elasticity problems in *Applied Mathematics and Mechanics*. There are also many other papers of considerable interest, for example, the paper on the flow of a gas at supersonic velocities by V S Tatarenchik (*App Maths and Mechanics*, 8, 401, 1943), which should be compared with current investigations by Southwell and his colleagues (*Nature*, 154, 90 and 834, 1944). N N Painsky gives (*Astron J S U*, 21, '78, 1944) the result of calculations which support Russell's criticism of Jeans' theory of the origin of the solar system. In addition to the journals mentioned above, we have also received a valuable atlas of nomograms, containing thirty-seven plates. All the publications received are being deposited in the Science Museum, South Kensington, London, S W 7, where they will be available for anyone who desires to consult them. By the aid of the summaries in English or French,

t should be fairly easy for those entirely ignorant of Russian to understand the results and methods of the papers

Belgian Visitors to Britain

THE fourth group of distinguished Belgians to visit Great Britain as representatives of the Belgian Fondation Universitaire and guests of the British Council have arrived in London. They are Prof M Florin, Faculty of Science and Medicine, Liège, Prof F Albert, Faculty of Medicine, University of Liège, Prof F Bremer, Faculty of Medicine, University of Brussels, Prof A Castille, Faculty of Medicine, Louvain, Prof J C Firket, Faculty of Medicine, Liège, Prof H R. Fredericq, Faculty of Medicine, Liège, M Jean Willems, director of the National Fund for Scientific Research (see p 780), and Prof L M Gyselynck, Faculty of Law, Brussels. They are meeting leading British authorities in their particular spheres in universities and research institutions in London, Cambridge, Oxford, Liverpool, Edinburgh, Glasgow and Belfast.

University of London

PROF D HUGHES PARRY, University professor of English law at the London School of Economics and a member of the Senate since 1930, has been elected vice-chancellor for the year 1945-46.

The title of professor emeritus has been conferred on the following: Prof Major Greenwood, professor of epidemiology and vital statistics since 1926, Prof. William Wilson, Hildred Carlile professor of physics at Bedford College from 1921 until his retirement in 1944, Prof Harold Simpson, professor of mathematics at Bedford College from 1912 until his retirement in 1944.

Prof C Daryll Forde, since 1930 Gregynog professor of geography and anthropology at University College, Aberystwyth, has been appointed to the University chair of anthropology tenable at University College as from October 1, 1945.

The degree of D Sc has been conferred on Dr E T Davies (Birkbeck College), Dr F W Jane (Birkbeck College), Mr S G Soal (Queen Mary College), Mr A C Frazer (St Mary's Hospital Medical School), Mr L A Allen and Mr C G Johnson.

Summer School in Colloid Science

THE Birmingham and Midlands Section of the Royal Institute of Chemistry has arranged, in co-operation with the Departments of Colloid Science and Physical Chemistry of the University of Cambridge, a Summer School in Colloid Science in the form of two courses, extending from June 23 to June 30 and June 30 to July 7 respectively. The director of tuition for the School is Dr A E Alexander. Both courses are being opened by Prof E K Rideal, professor of colloid science in the University of Cambridge and president of the Society of Chemical Industry, and the opening lectures are by Dr W Clayton, on "Foods as Colloid Systems" (course A), and Dr E H Callow, on "Colloids in Theory and Practice" (course B). Some two hundred research chemists are attending the School.

The Night Sky in July

New moon occurs on July 9d 13h 35m, UT, and full moon on July 25d 02h 25m. The following conjunctions with the moon take place: July

5d 06h, Mars 3° N, July 6d 02h, Venus 0 4° N, July 11d 10h, Mercury 2° S, July 14d. 12h, Jupiter 4° S. Only one occultation takes place in July, 20 Ceti reappearing on July 30d 00h 37 7m, the time refers to the latitude of Greenwich. Mercury sets at 21h 26m, and 20h 22m at the beginning and end of the month respectively, attaining its greatest easterly elongation on July 23, and is not very well placed for observation during the month. Venus is a conspicuous object in the early morning hours, rising at 1h 30m and 1h 08m at the beginning and end of the month respectively. Mars moves from the constellation of Aries into Taurus during July and rises at 0h 53m on July 1 and 23h 18m on July 31. Jupiter sets at 23h 15m at the beginning of the month and at 21h 27m on July 31, about an hour and a half after sunset, and is not easily observed. Saturn sets about quarter of an hour before the sun on July 1 and is not favourably placed for observation. The earth is at aphelion on July 5.

A total eclipse of the sun takes place on July 9, partly visible as a partial eclipse at Greenwich, where the eclipse begins at 12h 45m and ends at 15h 11m. The magnitude of the eclipse at Greenwich is 0.61. The central line commences in long 115° 57' W and lat 44° 23' N, and ends in long 72° 33' E, and lat 41° 43' N.

Announcements

PROF ARNOLD N SHIMMIN, now acting professor of industrial relations in the University of Leeds, has been appointed to the newly instituted chair of social science in the Department of Economics of the University.

DR KATHLEEN LONSDALE has been appointed by the managers of the Royal Institution to be Dewar Research Fellow in succession to Dr A R Ubbelohde.

THE Committee of Privy Council for the Organisation and Development of Agricultural Research has appointed Prof T G B Osborn, Dr J L Simonsen, and Mr W J Wright as members of the Agricultural Research Council in succession to Prof E J Salisbury, Sir Robert Robertson and Sir Robert Greig, whose terms of office as members of the Council have expired.

THE Library of the Chemical Society is now remaining open for longer hours, it is open from 10 a.m. to 6 p.m. on Mondays to Fridays and 10 a.m. to 5 p.m. on Saturdays.

THE fifth number of the *Revue d'Alger* published by the University of Algiers includes an interpretation of the American constitution, under the title "The Function of the President of the United States", by A Heekscher, an article by G Darmois on "The Tercentenary of the Birth of Newton with an Appreciation of his Work", and one by J Malmejac and S Cruck on "Penicillin: History of a Recent Discovery in Medical Therapy". G Cohen contributes a note on the Free School of High Studies at New York, urging the creation in Paris of a similar school for American students living in France, and M Koch a survey of the French Rhine and its economic and imperial role.

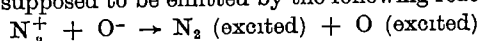
ERRATUM—In his communication on "Calculation of the Results of Microbiological Assays" in *Nature* of May 26, Mr Eric C Woods states that on p 633, line 11, "2 µgm" should read "0.1 µgm".

LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications.

Night-Sky Emission and Region F Ionization

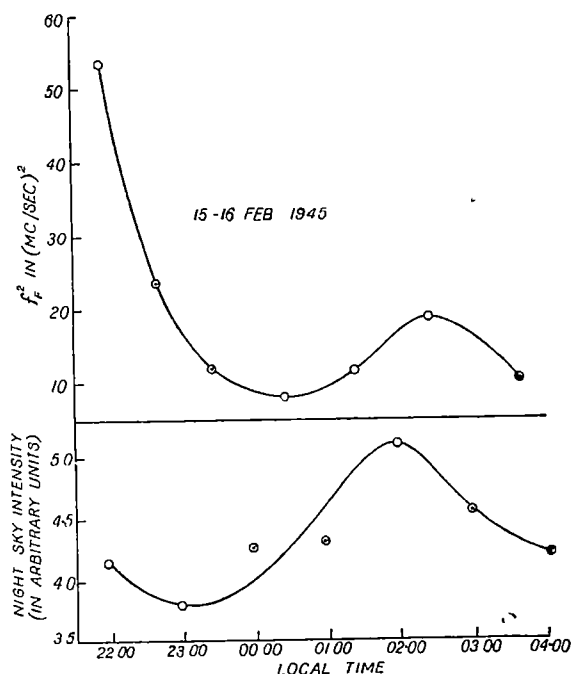
In the theory of emission of the night-sky spectrum recently proposed by me, the Region F of the ionosphere is identified as the luminescent layer¹. The characteristic night-sky spectrum in the visible region consisting of the first-positive and the Vegard-Kaplan bands of N₂ and the auroral green and red lines of O are supposed to be emitted by the following reaction.



The energy released in the process of neutralization by electron transfer is given by the ionization potential of N₂ (15.58 eV) less the electron affinity of O (2.2 eV). This energy is taken up almost entirely as energy of excitation of N₂ to the B³π state (v' = 9, 9.1 eV) and of O to the ¹S state (4.2 eV). (There is some uncertainty about the value of the electron affinity of O. While Lozier² gives the value as 2.2 eV, recent experiments of Vier and Mayer³ yield the value 3.0 eV. But even with the latter value there is sufficient energy available for raising N₂ to a high vibrational level of B³π, if account is taken of the kinetic energy of the colliding particles.) According to the theory therefore one would expect a positive correlation between variation of the night-sky intensity and variation of the electron content of Region F. Prolonged observations on the intensity of night-sky emission and on the Region F ionization density (square of penetration frequency f_F²) do show unmistakable correlation in respect of long-period variations of the two, for example, seasonal variation and eleven-year solar cycle variation^{4,5,6}.

For the case of short-period nightly variations, however, one would not expect too close a correlation between the two. This is because the nightly variation of f_F² may not correspond to the variation of the total electron content of the region, on which latter, obviously, the intensity of night-sky emission depends. Thus the total number of electrons in a column of unit cross-section may remain constant or even decrease, but f_F² may show an increase due to contraction of the layer as a whole by cooling. Again, the decrease in f_F² due to recombination proceeds much faster than the decrease in the total electron content due to the same cause.

There are, however, 'disturbed' nights on which f_F², as also the intensity of the night sky, vary abnormally. On such nights the variation of f_F² follows the variation of the electron content of the region as a whole and, as such, one may expect a positive correlation between the two. This is precisely what has been found, and furnishes evidence in support of the theory. Taking advantage of the black-out condition in the city, Mr S N Ghosh (Adair Dutt Research Scholar) has, for some time past, been keeping in my laboratory records of night-sky intensity variation on dark clear nights on which f_F² records were also being kept. It was found that on undisturbed nights on which the night-sky intensity shows a typical variation, f_F² also does the same, the two variations not necessarily following each other. On disturbed nights, however, on which f_F² exhibits abnormal varia-



tion, the night-sky intensity also varies abnormally, following the same trend. The accompanying figure depicts two such variation curves. It will be seen that they run approximately parallel to each other.

The night-sky intensity was measured photographically without any filter in the region 6° above the pole star. The photographic records were measured by a Moll microphotometer.

S K MITRA

Wireless Laboratory,
University College of Science,
92 Upper Circular Road,
Calcutta March 29

¹ Mitra, S K, *Science and Culture* (Calcutta), 9, 46 (1943). See also Ghosh, S N, *Proc Nat Inst Sci Ind*, 9, 301 (1943).

² Lozier, W W, *Phys Rev*, 48, 268 (1934).

³ Vier, D T, and Mayer, F E, *J Chem Phys*, 12, 28 (1944).

⁴ Rayleigh and Jones, H S, *Proc Roy Soc, A*, 151, 22 (1935).

⁵ Martyn, D F, and Pulley, O O, *Proc Roy Soc, A*, 154, 455 (1936).

⁶ Smith, N, Gilliland, T R, and Kirby, S S, *J Nat Bur Stand*, 21, 835 (1933).

X-Ray Topographs

WHERE a sizable crystal is to be used for investigations of structure-sensitive properties, for example, X-ray intensity measurements, photo-electric effect, etc., it is advisable to test its homogeneity. This may be simply done in the following way.

The crystal is irradiated by a wide beam of appropriately filtered X-rays, diverging from a pinhole placed close to the anticathode. A small piece of flat photographic film is mounted in a holder on the axis about which the crystal oscillates. The film is arranged to be parallel to the face of the crystal which it is required to examine. The crystal is then placed in the position for a Bragg reflexion to occur for this face, and the crystal and film are then oscillated through an angle sufficient for every part of the crystal to reflect. We have found Kodak Process film very satisfactory for this purpose and better than Crystallex, because, though its sensitivity is less, it is much finer grained.

With this arrangement an almost undistorted topograph of the surface of the crystal may be obtained with copper radiation. This is because the characteristic radiation is reflected at a constant angle from all parts of the surface and the image is built up, piece by piece, as the crystal rotates in the diverging beam.

We have investigated a number of diamonds by this method. The topograph of a face sawn through one peculiar interpenetrating twin of diamond is shown in the accompanying photograph, and it is seen that the reflecting power for X-rays varies greatly over the surface. This diamond showed no visible irregularities.



Associated with the stronger reflexions there is frequently found a streak extending sometimes on both sides of the central position. This is due to the 'angular spread' of the polycrystalline material at the reflecting spot. This method is therefore a convenient one for studying variations of texture of the material, which include relatively

large-scale imperfections corresponding to a visible angular spread and small-scale imperfections corresponding to variations in intensity of reflexion at the correct setting of the crystal.

Another diamond which was investigated in this way was sent to us for examination because of its anomalous behaviour in an abrasion test. The stone had been sawn in half, approximately parallel to the cube axis. One half had ground away at the normal rate, the other had proved extraordinarily resistant. Topographs of the ground surfaces were strikingly different, the part which had behaved normally showing a uniform reflecting power, but the part which had behaved abnormally showing obvious irregularities.

Topographs of these two pieces taken on the sawn faces were also interesting, showing quite clearly the existence of a skin. That the outside of a diamond frequently grinds at a different rate from the interior is alleged by most diamond cutters, but the evidence for it that is offered is generally subjective and not easily checked.

While we would not wish to maintain on the basis of this scanty evidence that resistance to abrasion is necessarily correlated with the perfection of the crystal structure, we suggest there is a *prima facie* case for investigation on these lines.

The topographs taken by G. N. Ramachandran¹ are in a sense complementary to those described here. He uses a Laue method and, by making use of hard radiation, examines the whole bulk of the stone, whereas we examine the superficial layers only.

We wish to thank Mr. Paul Grodzinski, of the Research Department of the Diamond Trading Co., for providing the stones and abrasion data, and for permission to publish these results.

NORA WOOSTER
W. A. WOOSTER

Brooklyn Crystallographic Laboratory,
Cherry Hinton Road,
Cambridge
April 6

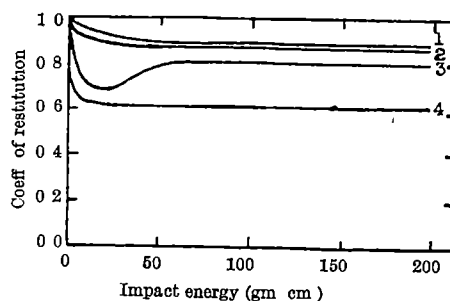
¹ Ramachandran, G. N., *Proc. Ind. Acad. Sci.*, 19, A, 280 (1944)

Coefficient of Restitution of Coals

In a previous note¹ it was mentioned that mechanical properties are involved in the Stopes classification of the petrological constituents of coals² and they are of interest in any general study of the physical properties of coals. Much of the previous work on this subject has been undertaken from the point of view of mechanical failures in mines, or breakage in handling. Stress-strain relationships for coals have been obtained³ by compression methods using large-scale engineering test machines, and while our experiments were in progress Bangham and Maggs⁴ reported measurements of the elastic modulus of coals in expansion on adsorption of vapours and in mechanical compression on a small scale.

Where the interest lies in the physical structure of coal, it is difficult to get a uniform specimen sufficiently large for direct measurement of the elastic modulus by a simple method. Although the coefficient of restitution is a composite constant, more difficult to treat theoretically, its measurement is simple even with small specimens, and the results are likely to reveal any essential differences in the elastic properties of a series of specimens. The height of rebound of small steel spheres dropped vertically on to a polished plane surface of the specimen was measured for a number of coals of varying rank. The mass of the spheres varied from 0.1 gm. to 12 gm. and the height of fall from 5 cm. to 15 cm. As a check on the technique, blocks of several metals including copper and mild steel were substituted for the coal specimen. It was found that the coefficient of restitution varied with the impact energy of the sphere, but that for any given value of this energy the results were independent of the size of the sphere.

A selection from the results is given in the accompanying graph. Curve 1 is for an anthracite from South Wales, curve 2 for durain from a Warwickshire hard coal, curve 3 for vitrain (with some claram bands) from a Warwickshire bright coal, and curve 4 for copper.



It was found that for all specimens examined, both coals and metals, at very low impact energies the coefficient of restitution tended towards unity with decreasing impact energy. The curves for all specimens of anthracite and durain examined and for metals were similar. With increasing impact energy, the coefficient of restitution drops from the initial high value and rapidly reaches a constant value. The specimens of the lower-rank bright coals, however, all exhibited a minimum in the coefficient of restitution at fairly low impact energies, the coefficient increasing to a constant value at higher energies. This minimum is clearly shown in the graph for Warwickshire bright coal (curve 3). At the higher impact energies the constant values of the coefficient

of restitution for the coals examined varied from 0.75 to 0.90, values considerably higher than those got for metals such as copper (0.62) and mild steel (0.73).

The coals which exhibited a well-defined minimum in the 'restitution-impact energy' curves were all bright coals which are in general much more brittle and friable than durains and anthracites, and in which occur visible cracks and well-defined cleavage planes. The depth of the minimum and the value of the impact energy at which it occurred varied from coal to coal. The minimum could indicate that at each impact an absorption of energy occurs in addition to the elastic strain energy absorbed. The additional amount of energy absorbed would initially increase from zero at zero impact energy, but rapidly reach some constant value independent of the impact energy of the sphere.

While the mechanism of this additional absorption of energy remains obscure, the effect has been suspected by previous workers. Holland² observed that coals subjected to high compression stresses exhibited hysteresis and permanent set, and only 85 per cent of the energy was released on removing the stress, 15 per cent strain energy being absorbed as permanent strain or appearing as heat. He suggested that the violence of rupture observed indicated that a large portion of this energy was released on failure of the specimen. In their mathematical treatment of coal breakage, Bennett, Brown and Crone³ formulated the hypothesis that, under stresses producing breakage, coals behave as brittle materials with a random distribution of inner planes of weakness. On fracture the energy is absorbed in forming new surfaces of the fragmented product, and in the creation of fresh inner weaknesses. As Heywood⁴ pointed out, this hypothesis neglects any elastic strain energy which may be absorbed, that is, assumes perfect elasticity. The experiments described above show that, with impacts too small to produce fracture, elastic deformations occur which absorb energy (since the coefficient of restitution is less than 1) and, in addition, energy is absorbed by some other mechanism in the case of low-rank bright coals. Most of the specimens used were kindly lent by Dr. Bangham of the British Coal Utilisation Research Association.

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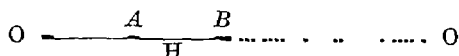
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Explanation of the Broadness and other Characteristics of Association Bands

THE broadness of the OH, NH or similar bands of pure liquids is well known, and there have been many postulates regarding its origin^{1,2,3}. We wish to show here that it is not necessary to assume any involved postulates regarding it, as it can be explained merely from the modern ideas of the mechanism of the formation of the hydrogen bond.

Pauling has shown that a covalent link has a partially ionic character. In the case of OH, for example, H is sometimes an atom enjoying a shared pair of electrons and sometimes a mere proton, the pair of electrons being attracted towards O by its electro-negativity. The two states alternate with what is called a resonance frequency. During the time H is a proton, it can approach another negative atom, say, O, for intense attractive interaction. Thus the H atom in a hydrogen bond moves between two points, say A and B, A being the position nearest to parent O, and where it rests ordinarily in the absence of a hydrogen bond.



Now, corresponding to each point of occupation by H on AB, there will be an OH band, with its own frequencies, and as the force constant will go on decreasing on proceeding from A to B, the breadth of the band is inherent in the formation of a hydrogen bond. Some other pertinent facts associated with hydrogen bonds are also explainable on the above mechanism.

(1) The breadth of the OH band will be greater, the stronger the hydrogen bond. As AB increases with the strength of the hydrogen bond, the breadth increases. Thus carboxylic acids possessing the strongest hydrogen bonds have the widest character of the association bands.

(2) As the concentration of molecules containing OH increases in an inert liquid, the association band will develop as a whole, that is, the character of the band remains independent of the concentration and only the intensity increases. As the association band due to hydrogen bonds arises in a complete form from each pair of molecules involved in a single hydrogen bond, the fact noted above follows.

(3) Since A is the limit of travel of the H proton (this being its rest position in the absence of hydrogen bond formation), the high frequency limit of the association band will end sharply at the high-frequency limit of the normal unassociated OH band.

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Hæmolytic Disease of the New-born caused by the Antibody St

RECENTLY hæmolytic disease of the new-born was described¹ where the *Rh*⁺ mother had in her serum an antibody since designated *St*² or γ^3 . From the observations of Race, Taylor and their collaborators^{4,5} the reactions of the known allelomorphs of the *Rh* gene with *St* serum may be summarized thus:

<i>St</i> serum	<i>Rh</i> ₁	<i>Rh</i> ₂	<i>Rh</i> ⁺	<i>rh</i>	<i>Rh</i> ₁	<i>Rh</i> ⁺	<i>Rh</i> ₂
	+	+	+	+	-	-	-

An eighth allelomorph, *Rh*₃, which is *St*⁻, is postulated by R. A. Fisher^{3,6}.

The genotypes found in the St family were mother, Rh_1Rh_1 , first and third children, Rh_1rh , father, Rh_1rh . The first child was unaffected. The second child died from hæmolytic disease, its genotype is not known, but is presumed to have been Rh_1rh . The third child recovered from hæmolytic disease after transfusion with St^- blood. Since this family was first described an unaffected fourth child, genotype Rh_1Rh_1 , has been born, no augmentation of the mother's antibody occurred with this pregnancy.

We have now observed a second family with hæmolytic disease of the new-born caused by the St antibody. The known genotypes are mother, Rh_1Rh_1 , affected child (the second pregnancy), Rh_1rh , father, Rh_2h (Rh_2Rh_2 and Rh_2rh are not distinguishable with the sera available to us, but the father is evidently heterozygous). The first child died in circumstances suggesting hæmolytic disease. The second child, mentioned above, died from hæmolytic disease, and a third pregnancy has recently terminated in abortion at the fourth month.

The mother's serum was examined after her second pregnancy and an antibody was found which agglutinated all of 35 Rh^- group O bloods tested. Identical results were observed using the original St serum and the new serum on a panel of 41 group O bloods (35 +, 6 -). The probability of observing this result by chance is less than 1 in 4 million ($6^1 \times 35^{1/41}$), and it was evident that identical antibodies were present in the two sera. The new serum also gave the 'dosage effect' observed with the original St serum⁴, that is, the titre was considerably higher for erythrocytes containing two St^+ antigens than for those containing one such antigen. It is supposed that in both cases the St^- mother was immunized by foetal rh , the birth of a normal fourth child (Rh_1Rh_1) in the first family is consistent with this hypothesis.

There is evidence^{8,9} that about 90 per cent of mothers bearing children affected by hæmolytic disease are Rh^- , and that the disease results from iso-immunization of the Rh^- mother by an Rh^+ foetus (Rh iso-immunization). The disease is much more likely to appear when the father is homozygous, and every pregnancy (all Rh^+) can provide an antigenic stimulus, in these circumstances the prognosis for future pregnancies in an affected family is entirely unfavourable^{10,11}.

It is of interest to estimate the frequency of matings and pregnancies in which St iso-immunization might occur. If only the common genes Rh_1 , Rh_2 and rh are considered, the mother, who must be St^- , can only be Rh_1Rh_1 . Theoretically, foetal Rh_2 may cause St iso-immunization, and although this does not seem to have been observed it may have occurred with the first and third pregnancies in our second family. From analogy with Rh iso-immunization it would seem that when hæmolytic disease occurs from St iso-immunization and the father is rh or rh , the prognosis for future pregnancies is entirely unfavourable (all children Rh_1rh), and if foetal Rh_2 may cause St iso-immunization the outlook is similarly unfavourable with Rh_2Rh_2 and Rh_2rh fathers. Using the frequencies suggested by Taylor and Race¹² for the common genotypes (rh rh , 13, Rh_1Rh_1 , 19, Rh_1rh , 33, Rh_2Rh_2 , 13, Rh_2rh , 12, Rh_2Rh_2 , 2 per cent) we obtain approximate estimates of matings and pregnancies in which St iso-immunization might occur. (1) Including Rh_2 as an immunizing antigen (a) St^- women and St^+ men, 13.9 per cent of all

matings, (b) St^+ pregnancies with St^- mothers, 1 per cent of all pregnancies. (2) If foetal Rh_2 is included the corresponding figures are (a) 11 per cent (b) 6.7 per cent. Applying the same genotype frequencies to ordinary Rh iso-immunization of rh mothers, we get (a) Rh^- women with Rh^+ men, 10.3 per cent of all matings, (b) Rh^+ pregnancies with Rh^- mothers, 7.3 per cent of all pregnancies. From these data it might be expected that Rh and iso-immunization would occur with about equal frequency, but since some 90 per cent of mothers bearing children with hæmolytic disease are Rh^- , it is clear either that St iso-immunization occurs much less frequently or that its effects are usually unrecognized.

The relative infrequency of recognized St iso-immunization requires explanation, and it may be supposed either that the St^+ antigens are usually weak, or that there is a selective placental impermeability to them. In support of the first hypothesis is the fact that although the occurrence of transfusion reactions from Rh immunization is well established, no similar reactions from St immunization appear to have been recognized.

In addition to the two examples observed by us we are aware of a few other cases of hæmolytic disease in which St antibody has been found, and seems not unlikely that St iso-immunization was responsible for the disease in the three families mentioned by Race, Taylor *et al.*¹⁰ with Rh^+ mothers and Rh^- husbands.

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The Race-Wiener Test in Hæmolytic Disease of the New-born

Race¹ and Wiener² described in 1944 independently a peculiar phenomenon concerning the Rh agglutination. When Rh^+ red blood corpuscles were incubated with some sera which did not agglutinate them, after further incubation with potent anti- Rh sera failed to produce an agglutination of these cells. Race called the antibody present in such sera the 'coating' or 'incomplete' antibody, Wiener designated the test as a 'blocking' test and called it the 'counterpart of the inhibition test for haptens and group-specific substances'. Wiener as well as Race and Taylor³ stressed the fact that by means of this test iso-immunization can be detected in Rh^- women when ordinary agglutination tests fail to give such evidence.

No investigations on sera of babies with hæmolytic

disease of the new-born have been yet reported. Anti-*Rh* agglutinins are only exceptionally met with in sera of babies with hæmolytic disease of the new-born. Boorman, Dodd and Mollison⁴ observed, once their presence in twins, and I reported⁵ one weakly positive test in a case of icterus gravis neonatorum. Since then, I have seen one definite reaction in the cord serum of a hydrops foetalis and four weakly positive agglutination tests in icterus gravis neonatorum. Since the publications of Race and Wiener their test has been applied to sera of fifteen babies with hæmolytic disease of the new-born, to nine sera of *Rh*- negative mothers of such babies which gave negative or doubtful reactions in routine anti-*Rh* tests, and to four sera of *Rh*- women with a history of miscarriages but no clinical or serological evidence of iso-immunization. Among the fifteen sera of babies there were seven positive Race-Wiener tests, six negative and two doubtful. All nine sera of mothers of babies with hæmolytic disease of the new-born gave positive results. In the last group there were three negative and one positive result.

Not all *Rh*+ red blood cells are suitable for this test. According to Race¹, sera giving a positive blocking test have an incomplete Δ agglutinin acting on the partial agglutininogen which has been designated by Fisher as *D*. Red blood cells of the phenotypes *Rh*₁, *Rh*₂, *Rh*₃ and *Rh*₄, which together form the majority of *Rh*+ cells, possess the *D*-agglutininogen and can therefore be coated by the incomplete antibody. Fisher's theory appears at the present moment to be the most satisfactory explanation of the intricate *Rh* agglutination phenomena.

I think it premature, however, to be dogmatic about a definite conception of the antigenic structure of the *Rh* factor. We have to realize that Landsteiner's⁶ investigations on conjugated antigens have shown that to a mosaic of serological reactions there need not always correspond a co-ordinate mosaic of chemical structures in the antigen. Whatever be the explanation of the hapten properties in the eight known *Rh* allelomorphs, the fact remains that some *Rh*+ cells fail to be coated in the Race-Wiener test, and that the inhibition may be complete in some specimens and only partial in others. For this reason I always use for the test ten different samples of *Rh*+ red blood corpuscles in two parallel series, one treated with the patient's serum, the other with the serum of an *Rh*+ individual. Into each of ten small test tubes (45 mm length, 7 mm bore, round bottom) 0.04 c.c. of the patient's serum is delivered from a marked Pasteur pipette. In a second series of tubes equal amounts of the control serum are placed. 0.04 c.c. of 2 per cent suspensions of ten different *Rh*+ red blood cells are then run into each tube of the test and control series. Both are incubated for one hour. After this time 0.04 c.c. of a suitable dilution of a potent anti-*Rh* serum is added to each tube, the tubes thoroughly shaken and reincubated for another hour. The test is positive when the majority of samples in the test series show definitely weaker reactions than those in the control series or no agglutination at all. The highest dilution of the standard anti-*Rh* serum which still produced coarse agglutinates in a suspension of standard *Rh*+ cells was considered as suitable for this test.

From the foregoing discussion, it is evident that the Race-Wiener test enables us to diagnose in an appreciable number of cases iso-immunization from the babies' sera, to ascertain iso-immunization when the mother's serum does not agglutinate *Rh*+ cells

and to decide occasionally in cases of *Rh*- women with a history of miscarriages whether iso-immunization has taken place.

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Kojic Acid and the Antibiotic Action of Species of *Aspergillus*

It was shown recently¹ that under specified cultural conditions the whole of the antibacterial activity of metabolism solutions from *Aspergillus effusus* Tiraboschi can be attributed to kojic acid. It was suggested that this common mould metabolic product might similarly account for the inhibitory properties of other fungi.

Some time ago, in a preliminary account of the production of antibiotics by selected species of *Aspergillus*², we described the formation by *A. parasiticus* of a material resembling penicillin. In investigating the effect of varying cultural conditions on antibiotic production by this and other species, kojic acid was often observed to be present in the metabolism solutions, but there was ample evidence of the formation of other antibiotics in addition. The observations described below, which were repeatedly confirmed, are recorded with special reference to *A. parasiticus* because of the marked tendency of this mould to produce kojic acid³.

When *A. parasiticus* was grown on a Czapek-Dox synthetic medium with the addition of 0.1 per cent 'Difco' yeast extract, it ceased to give the penicillin-like antibiotic reported earlier, the solutions developed antibacterial activity against *Staphylococcus aureus*, which was not lost on standing the solutions at pH = 1.8 or 11 for 90 min. and was only partly lost after heating to 90° for 30 min. Further tests showed that the antibacterial activity of the culture fluids varied with the amount of sugar present in the medium. In solutions containing 0.5 or 1 per cent glucose, activity against *Staphylococcus aureus* appeared about the twelfth day and the solutions remained active for three to four weeks, colour tests for kojic acid were negative throughout this period and the solutions were entirely inactive against the Gram-negative organisms *E. coli* and *Ps. pyocyaneus*. In 2 per cent glucose solutions kojic acid was present, and slight activity against *E. coli* and *Ps. pyocyaneus* developed from the fifth to the seventh day, after which all activity disappeared until about the thirteenth day, when antibiosis was again produced but against *S. aureus* only, tests for kojic acid were then negative. In 4 per cent glucose solutions the dual phase of activity became still more marked. Activity against *S. aureus* appeared about the fifth day, reached a maximum on the eleventh day and then fell sharply to zero. Tests at 18-22 days were completely negative, but the culture fluids were again

ctive about the twenty-fourth day and were still ctive after fifty days. During the first phase kojic cid was present in the solutions, which were active ot only against the Gram-positive organisms (*Staphylococcus aureus*, *B. megatherium* and *Bact. ziscians*, but also against a range of Gram-negative acteria, namely, *E. coli*, *Ps. pyocyaneus*, *Chr. rodigeosus*, *Ps. fluorescens liquefaciens*, *Bact. aerones* and *B. carotovorus*. During the second phase he solutions inhibited the growth of Gram-positive rganisms only.

When 1, 2 or 4 per cent lactose was used in place f glucose, all the lactose cultures and those containing and 2 per cent of maltose were similar in antibiotic roduction to those containing 1 per cent of glucose, a 4 per cent maltose antibacterial activity exactly aralleled that produced in 4 per cent glucose solutions, with a transient formation of kojic acid during he first phase of activity.

Attempts were made to find convenient substitutes or yeast extract, without which antibiosis was considerably delayed and was less pronounced. Freshly prepared extract of bakers' yeast and an extract of etuue seedlings were effective supplements, but individual compounds such as aneurin, lactoflavin, antiothemic acid, pyridoxine, *p*-aminobenzoic acid, or heteroauxin, were almost valueless. The dual phase of activity when 4 per cent glucose was used n these media was apparent in the culture fluids f all these solutions, though it was not always so learly marked as in the experiments described above.

Clearly at least two antibiotics were produced in hese experiments, the speed of their production apparently depending on the availability of the carbo- ydrate nutrient, but it is possible for the following easons that more than two antibiotics were being ormed. (a) The activities against the range of rganisms examined did not run parallel during the rst phase. For example, in 4 per cent of glucose after eight days, the solutions inhibited *Staph. aureus* t a dilution of 1/100, with only a trace of activity against *E. coli*, after ten days the solution was bout equally effective (limiting dilution 1/100) against these two organisms, whereas after sixteen lays it was less active against *Staph. aureus* than against *E. coli*. (b) During the early part of the first phase of activity, kojic acid was detectable in solu- ion and was readily isolated, its activity proved o be small, as it inhibited *Staph. aureus*, *E. coli* and *Ps. pyocyaneus* at a limiting dilution of 1/2,000–3,000, and there was a very considerable discrepancy between the amounts of kojic acid isolated and he amounts which would have been anticipated if it had been responsible for all the antibacterial activity. Moreover, kojic acid disappeared from the solutions before the latter part of the first phase was reached and did not reappear during the more restricted second phase.

Several products from kojic acid (for example, mono- and di-acetyl, monobenzyl, monomethyl ether derivatives) were examined, but their effectiveness against *Staph. aureus* was negligible. The antibiotic produced during the second phase was easily ex- tracted from acid solution by ethyl acetate and the ctivity could be recovered in neutral solution. The hemical nature of these products is being ex- amined. It is evident in these experiments that ven though kojic acid is produced, only a part f the antibacterial activity can be ascribed to this ompound.

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Root-formation on Cuttings of Plants which Normally do not Root

THE process of rooting of cuttings has proved to be a very complex problem. A good deal of work has shown that root-formation on stem and leaf cuttings depends on many factors, of which auxin and carbohydrate are the most important^{1,2,3}. This work has enabled many investigators not only to produce, more quickly, more numerous roots on cuttings which normally root easily, but also to induce root-formation on cuttings which normally do not root. Thus Cooper^{4,5}, Hitchcock and Zimmerman⁶, and many others have obtained excellent root-formation on cuttings of many economically important plants by application of auxin alone or with sugar solution.

In the present investigation, we are trying to induce rooting of cuttings from *Bougainvillea spectabilis* var. *Lateritia*, and *Mangifera indica*. Cuttings of *B. spectabilis* usually root successfully (success is normally 50–60 per cent), but cuttings from the variety *Lateritia* do not root normally. We have, however, succeeded in inducing root-formation on 50 per cent of woody cuttings from the latter variety by basal application of β -indole acetic acid solution. Different concentrations of the latter have been used for different periods of time, the optimum concentration being 0.015 per cent for a period of twelve hours. Feeding with sugar solution after the application of hetero-auxin did not increase the number of rooted cuttings, thus suggesting that the cause of failure of these cuttings to root under normal conditions is the shortage in the auxin and not the food factor.

Cuttings of *Mangifera indica* have been more difficult to root, but the experiments, which are now in progress, seem to indicate that these cuttings do respond to auxin application. Basal application of β -indole acetic acid solutions induced formation of root initials on these cuttings (collected last autumn), but the cuttings shrivelled and died later in the winter. Cuttings will be collected and treated in different seasons, and the results will be communicated later.

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Two Colour-Types in *Solitaria*-Phase Adults and Hoppers of the Desert Locust

COLOUR differences between the *gregaria* and *solitaria* phases in the desert locust, *Schistocerca gregaria* (Forsk.), are well known. In the *gregaria* phase the adults are pink when immature and yellowish when mature (Kunckel d'Hercula¹), *solitaria* adults are greenish when very young and greyish afterwards (Johnston²). *Gregaria*-phase hoppers have a black pattern, *solitaria* hoppers lack this pattern and are green (Johnston², and others) (*Vide* also Kennedy's³ recent account of coloration in *solitaria*.)

I have however observed, both in Nature in Baluchistan as well as in the laboratory, that two distinct colour-types occur in the *solitaria* phase among adults and hoppers. (1) *Adults*. Among 367 adults examined, the majority (about 91 per cent) were suffused with a blue-grey tinge, resembling the *solitaria* individuals mentioned by Johnston, others (about 9 per cent) had no blue-grey but were fawn all over. The occurrence of the two types has no relation to age or season. (ii) *Hoppers*. The majority of *solitaria* hoppers are green. Occasionally, however, both in Nature and in the laboratory, fawn-coloured hoppers, with no trace of green, turn up, as briefly reported earlier in an account of my painted-box experiments (Roonwal⁴). Though exact figures are not available, my distinct impression is that the frequency of occurrence of the fawn hoppers did not exceed about 10 per cent. The colour difference was especially noticeable from the third stage onward, and was not correlated with the environment, as shown by rearing experiments as well as field observations.

It is probable that (a) the fawn hoppers give rise to fawn adults, and green hoppers to the blue-grey adults, and (b) the two colour-types have a genetical significance, since they are not related to phase or environment.

A detailed account will be published elsewhere
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Chemical Constitution of the Nucleolar Inclusions in Growing Oocyte Cells

IN many animals during the second period of growth of the oocyte there is a production of nucleolar substance by means of a multiplication of numerous little nucleoli, or the budding of small nucleoli from a principal nucleolus¹. When a principal nucleolus exists, in general concomitantly with the production of the buds, some inclusions with a more or less vacuolar appearance are formed in its interior¹. In a study of the nucleolar physiology in two species of Helicidae—*Helix aspersa* Mull. and *Tachea nemoralis* L.—we have examined the constitution of these inclusions. They are not aqueous vacuoles, though they can be, and probably in general are, less dense than the body of the nucleolus, when centrifuged they are not markedly dislocated and in concentrated salt solutions the volume of the inclusions does not diminish more than the rest of the nucleolus.

By means of the histochemical arginine reaction² we have seen that these inclusions are less rich in arginine than the body of the nucleolus. Millon's reaction for tyrosine and the test for protein SH groups³ are also less strong in the inclusions. On the other hand, Voisenet's reaction for tryptophan⁴ gives a violet coloration more intense in these inclusions.

The Feulgen reaction is completely negative for the nucleolus and the inclusions, while a histochemical test for organically bound phosphorus is positive for the nucleolus body and is more intense in the inclusions. This phosphorus test consists essentially in a slow hydrolysis of the tissues by a molybdate-hydrochloric acid reagent followed by treatment with an acetic solution of benzidine and saturated aqueous sodium acetate⁵. This test demonstrates the presence of phosphorus in thymo- and ribo-nucleic acids, and the reaction is very intense, for example, in the spermatozoa heads and the chromosomes of dividing cells. The test reveals the presence of phosphorus in conjugated phospho-proteins and specially in nucleoproteins.

The coloration of the oocytes with basic (toluidine blue) and acidic (Ponceau PR) stains, minimizing at the same time the adsorption⁶ by addition of 1 per cent saponine, gives results which agree with the histochemical tests. Toluidine blue gives a coloration more intense in the inclusions than in the rest of the nucleolus, while the contrary happens with Ponceau. By means of nucleases extracted from rice bran⁷ we have digested the nucleic acids. After this digestion, the inclusions do not show any differential response to staining and the phosphorus test is negative.

It is known that the nucleolus is formed of, at least, basic proteins and also some non-basic proteins^{7,8}, and nucleotides of the ribose type⁸. It seems that we can safely conclude that the phosphorus reaction, the coloration with basic and acidic stains and the nuclease action, show the existence of nucleotides of the ribose type in the nucleolus, and the nucleolar inclusions must have a greater concentration of these nucleotides than the remaining part of the nucleolus. It would be interesting to test the same material by means of the ultra-violet microscope.

This accumulation of nucleotides in the inclusions is probably related to the production of nucleoproteins rich in basic proteins, by the nucleolus during the elaboration of the cytoplasm and the yolk of the growing oocyte. The nucleoli are more rich in nucleotides (phosphorus test) when young. It is possible that the synthetization of nucleotides is a function of the nucleolar inclusions, while the basic proteins are particularly formed in the nucleolus body.

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A Simple Method for the Establishment of Geometrical Progressions by Diluting with the Pipette

In serology and biochemistry it is a daily task to ascertain by so-called serial tests the effective dose of any substance, for example, to establish the titre of the agglutinating power of a serum, to find the strength of a haemolytic amboceptor, or the smallest concentration of salt that just precipitates a colloidal solution, etc

We can carry out the serial tests by preparing solutions of the substance in question in the form of an arithmetical or geometrical progression. Michaelis and Rona¹, and many others, have shown, however, that this procedure as it is often carried out is the source of various errors, when the series are laid out in the form of arithmetical progressions

Let us, for example, examine the sodium chloride series which was prescribed by Kafka for the establishment of the smallest gold-sol precipitating salt concentration (or mastic-sol ones)

Salt conc (%)	0	1	2	3	4	5	6	7	8	9	10	11	12
Difference (%) between various tubes		100	50	33	25	20	16	14	12	11	10	9	

The variation in percentage differences between consecutive concentrations in the above series is clearly undesirable for quantitative estimations. In the great majority of cases it is necessary to estimate, with approximately the same percentage error, at whichever part of the series of dilutions the indicating tubes occur. This is ensured by the use of serial dilutions, in which the ratio of concentrations of the reagent in any two adjacent tubes is the same throughout the series. The preparation of such a geometrical series with any required ratio of concentrations between the contents of adjacent tubes is much facilitated by the use of a simple algebraic formula

A series of tubes is placed in a row. Into the first tube a convenient amount (V) of the reagent is accurately measured. Into each of the remainder of the tubes the same volume of the diluent is measured. Into the second tube is measured also a volume (K) of the reagent, where

$$K = \frac{V}{Q - 1},$$

Q being the ratio of concentration between the contents of adjacent tubes, which is appropriate for the experiment. The contents of tube 2 are then thoroughly mixed and a volume K of the mixture transferred from tube 2 to tube 3. After mixing, a volume K is transferred from tube 3 to tube 4, and so on through the series.

As an example, we may revise the Kafka salt concentration series cited above. If we arrange the twelve dilutions in a geometrical series, the value of Q to cover the range of dilutions from 0.1 to 1.2 per cent is 1.2535. This is arrived at by dividing the difference of the logarithms of 1.2 and 0.1 by 11 (the number of intervals between tubes) and taking the antilogarithms. If we use $Q = 1.25$, the highest concentration should be 1.16 per cent instead of 1.2 per

cent. Then with $V = 0.5$, $Q = 1.25$, $K = \frac{0.5}{0.25} =$

2 c.c., 0.5 c.c. of the 1.16 per cent solution is put into tube 1 and 0.5 c.c. of the diluent into each of the other tubes. The 2 c.c. of 1.16 per cent is added

to tube 2, mixed, and 1 c.c. of the mixture transferred to tube 3, 2 c.c. is then transferred from tube 3 to tube 4, and so on.

If the same pipette is used for each of the successive dilutions, it is important that it should be a very accurate one, as any errors in its calibration cumulate rapidly. If, for example, a 5 per cent deficiency occurs at every stage of successive dilution, the last tube of a series of twelve will have little more than half its true concentration.

In conclusion, I should like to express my sincerest thanks to Dr J. W. Trevan, director of the Wellcome Physiological Research Laboratories, for criticisms and advice.

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¹ Michaelis and Rona, "Praktikum der physikal. Chemie" (1932)

Potato Dry Rot and Gangrene as Soil-borne Diseases

Dry rot was described as a storage disease of the potato nearly forty years ago^{1,2}, and has since become of increasing economic importance, yet only recently has attention been paid to the soil as a source of infection. The control of the disease obtained by the use of organo-mercury dips at lifting time³ and the marked variation in its severity in stocks of the same variety from different farms lent support to the assumption that the causal fungus (*Fusarium caeruleum*) was soil-borne. No attempt had, however, been made to provide direct experimental evidence of this until last year, when Small^{4,5} showed that *F. caeruleum* was often present in the soil adhering to healthy tubers both at lifting time and during storage.

We have carried out experiments to determine the presence of the fungus in soils from selected fields in Scotland and to discover whether any variations could be detected in the degree of infestation. In the autumn of 1943, bulked random samples of soil were taken, with aseptic precautions, from twenty fields. Potatoes of the susceptible variety Doon Star were inoculated with small quantities of the soils, twenty-five tubers, each inoculated in two places, being used for each sample. A fresh sterilized inoculator was used for each tuber.

RESULTS OF INOCULATING POTATO TUBERS WITH SOIL TAKEN FROM TWENTY SCOTTISH FIELDS IN OCTOBER 1943

Date of last potato crop	Number of fields	Percentage of inoculations causing dry rot
1941	1	32
1942	11	52, 22, 16, 10, 6, 6, 4, 2, 2, 0, 0
1943	8	88, 24, 20, 4, 4, 4, 2, 0
Control sterilized soil		2
Control spore suspension of <i>F. caeruleum</i>		100

The infection of one wound in the first control series was presumably due either to imperfect sterilization or to chance air-borne contamination.

Isolations from random samples of infected tubers showed that the causal organism in almost every case tested was *F. caeruleum*.

The results summarized in the table show that *F. caeruleum* may be present in the soil at least two years after the last potato crop, and that marked variations in the degree of infestation of the soil samples were detected by the method used. Experiments on a larger scale are now in progress to ascertain whether such variations can be correlated with

the amount of dry rot developing naturally in tubers of susceptible varieties taken from the same fields as the soil samples. Further investigation is necessary to determine whether the fungus is a normal inhabitant of certain soils or a soil invader⁶.

Gangrene caused by *Phoma foveata*⁷ has also been assumed to be a soil-borne disease, although, so far, there has been no experimental evidence of this. During a previous experiment we isolated *P. foveata* from typical gangrene lesions developing on some tubers inoculated with soil from two fields in Scotland, both of which had last been cropped with potatoes in 1942, that is, one year before the soil samples were taken. This disease, therefore, may also be regarded as soil-borne.

Details of the above experiments and other work on the epidemiology and control of dry rot are in the course of preparation for publication.

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¹ Pethybridge, G. H., and Bowers, E. H., *Econ. Proc. Roy. Dub. Soc.*, 1, 547 (1908).

² Pethybridge, G. H., and Lafferty, H. A., *Sci. Proc. Roy. Dub. Soc.*, 15, (N.S.), 21 (1917).

³ Foister, C. E., and Wilson, A. R., *J. Min. Agric.*, 50, 7 (1943).

⁴ Small, T., *Nature*, 153, 436 (1944).

⁵ Small, T., *Ann. Appl. Biol.*, 31, 290 (1944).

⁶ Reinking, O. A., and Manns, M. M., *Z. Parasitenk.*, 6, 23 (1933).

⁷ Alcock, N. L., and Foister, C. E., *Scot. J. Agric.*, 19, 252 (1936).

Mass Production of Virus-free Potatoes

UNDER the powers given by the Agricultural Pests Act, 1911, a reserve comprising the Riet River Settlement and all land within ten miles of it¹ has been set aside for growing virus-free potatoes. The Settlement is one of the newer irrigation projects in the Union. It is now being farmed by the State in preparation for the return of men from the armed forces who will occupy it after the War, and it was partly to provide them with a new and profitable industry that the reserve was created.

But primarily the object of the reserve is to break away from the ordinary system of seed production, in which the aphid-transmitted viruses are permitted in small amounts and at least those strains of virus X allowed which cause no visible mottling of the leaves. Circumstances have brought this system about, but although it has been almost universally accepted we should not delude ourselves that it is anything but the makeshift that it is. The plants with aphid-transmitted virus diseases are always a danger, even if they are only few, and except in the very best areas the grower is committed to an endless battle against infection spreading from them. The worst strains of virus X can be kept in check by destroying mottled plants, but under the present system milder strains spread unhindered. A few years ago this might not have seemed a serious objection, but we now know that even the weakest strains which cause no visible symptoms on potatoes substantially reduce the yield^{2,3}.

The only way to deal with virus X in susceptible varieties and the best way with other viruses is to get rid of them altogether. Bald⁴ tells how stocks free from virus X are being grown in Australia. In

Britain the matter has been taken further, and Smith and Markham⁵ describe how the island of Islay off the coast of Scotland is being used for raising virus-free potatoes. Similar isolation is the object of the Riet River scheme, but the scheme goes further and aims not just at producing seed free from every known potato virus, but at supplying it in such quantity that it meets the ordinary demands for good seed. For South Africa, small as its potato industry is, these are put at about five thousand tons a year, or more.

The idea is to have a reserve of sufficient size from which all viruses are excluded. In such a reserve the growers would have a multifold advantage. They would get the highest quality at less cost, partly because they would not be burdened with practices like the removal of infected plants, and partly because yields would reflect the absence of virus X and other infections which depress productivity. In an isolated reserve freedom from virus can be made its own reward, and virus-free seed can be produced not as a speciality, but in bulk and more efficiently than ordinary seed is grown at present. That is the essence of the matter.

The decision to grow virus-free seed at the Riet River Settlement was made several years ago. The area has many advantages. It is well isolated. Disease-carrying aphids are scarce in its hot, dry climate⁶. Experience with the ordinary grade of seed grown there showed that in quality and productivity it equalled anything planted in the Union⁶, Scottish and Irish seed not excepted.

To maintain adequate isolation, regulations made under the Act already mentioned are being used to prohibit the entry of all unauthorized potatoes. For safety's sake, all land within ten miles of the Settlement has been added to the reserve, but few potatoes are likely to be grown there. Outside this boundary (except for an irrigable strip higher up the Riet River which may still be proclaimed) is dry grazing country, too dry for crop farming. Potatoes are planted only in scattered kitchen gardens under irrigation, and then only rarely. The nearest point at which they are grown on any scale worth mentioning is about forty miles away, while there is no intensive potato culture anywhere within a hundred miles. Isolation of this sort will, it is hoped, stop the infiltration of virus into the reserve, but to allow for the chance of occasional introductions the State will continue to grow a small acreage of tested seed which will be used for the frequent renewal of settlers' stocks.

A stock has been built up sufficient to produce the first thousand tons of seed within the next year. So far as one can test, this is free from all potato virus diseases, except leaf-roll, which is present in small amounts. Completely virus-free seed will, it is hoped, be available in bulk a year later.

It is too early to say how far seed production on this type of country can be extended. A full answer must wait until the Settlement's five thousand acres of suitable land are occupied after the War. But there is enough evidence for a preliminary assessment of the position. To the plant pathologist the prospects are favourable. Apart from virus diseases, the climate completely controls *Phytophthora* blight, black leg and powdery scab—to name only tuber-borne infections—and to judge from results in Kansas⁷ gives an easy method of controlling *Rhizoctonia*. Diseases more suited to the climate may still appear, but there is no evidence of them yet. For the agronomist the issues are less favourably

balanced, and it is on him that future expansion really rests. The climate has its virtues. One might mention particularly the remarkable speed of tuber formation which allows main-crop varieties to set a good yield of seed-sized potatoes within six weeks of emergence, and which may probably be attributed to the intense radiation during the fairly short days, and to the great contrast in temperature between day and night. Against these are various cultural difficulties, especially those associated with the high temperature of the soil through which the shoot must emerge. While they have not stopped the rapid building-up of seed stocks in the past, they remain a danger which cannot safely be ignored, and on their solution hangs the possibility of eventually bringing into use the practically limitless area of suitable climate.

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Riet River Settlement,
P O Modder River

¹ Proclamation 4, 1945, S African Govt Gazette, Jan 9, 1945

² Bald, J G, Council for Sci and Indust Res (Australia), Bull 165 (1943)

³ Smith, K M, and Markham, R, *Nature*, 155, 38 (1945)

⁴ Bald, J G, *J Council Sci and Indust Res*, (Australia), 17, 258 (1944)

⁵ *Nature*, 153, 589 (1944)

⁶ For a farmer's opinion of seed from the sister settlement at Vaal Harts, seventy miles away in a similar climate, see (S African) *Farmer's Weekly*, 58, 1284 (1945)

⁷ Elmer, O H, *Phytopath*, 32, 972 (1942)

Swimming of *Monas stigmatica*

WHILE not disputing the relatively high speed attained by this organism¹, exception must be taken to Mr A G Lowndes' statement "thus the organism has a relative speed of more than forty, or, in other words, traverses forty times its own length in a second, and on this simple calculation the organism has a relative speed which is twice that of the most modern 'Spitfire' and a thousand times that of a modern destroyer". The figure for a destroyer is nearer two hundred in lieu of one thousand. Moreover, the 'length', for the purpose of such a comparison, should be a dimension in the same plane as the direction of motion.

As this is essentially a hydrodynamic comparison, the well-known law of corresponding speeds should be applied, the correct criterion being speed divided by the square root of the length, and not speed divided by the length as Mr Lowndes states.

The organism as described is a screw propeller rather than a hull. That being so, the most important criterion is the relative speed of rotation. This, by the law of corresponding speeds, is the number of revolutions per unit time, multiplied by the square root of the diameter. If Mr Lowndes can measure the revolutions per second of the organism, it would be extremely interesting to compare its relative rotational speed with that of a 'Spitfire' airscrew or a destroyer propeller.

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¹ *Nature*, 155, 579 (1945)

DR TUTIN is a member of the Institution of Naval Architects, and I accept his statement that the relative speed of *Monas stigmatica* is only about two hundred

times that of a modern destroyer. In the past, the relative speed of living organisms has always been expressed as the ratio *distance per sec/length of organism*¹. It would indeed be interesting if one could measure the revolutions per sec of the organism, but I fear this is impossible at present, since it could only be done either by the use of high-speed photomicrography or by the use of the stroboscope attached to the microscope.

A camera giving 1,200 exposures per sec, each exposure of the order of 1/50,000 sec, is normally available here and the cost of film is only about 6d per sec². Unfortunately, owing to the small size of the organisms, high powers of the microscope are essential and this means confining the organisms within a small space and subjecting them to an intense illumination. Under these conditions the swimming of these organisms is quite abnormal, and they usually stop swimming altogether. This being so, neither the film nor the stroboscope would mean anything.

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¹ *Tabulae Biologicae*, 4, 478

² Lowndes, A. G., "The Twin Polygraph and Strobograph", *Nature*, 135, 1008 (1935)

Scientific Material in Occupied Europe

MANY people have been perturbed by reports that the Nazis had applied to scientific material the same process of spoliation and confiscation that they had carried out so systematically in the realm of art. For example, on the liberation of southern Holland, it was reported that the Wasmann collection of ants had been forcibly removed from Maastricht to Berlin.

Recently, however, I have received a letter from Dr Wilhelmina van de Geijn, of the Maastricht Museum, which indicates that in this case the loss has not been so severe as was first feared, thanks to her courage and presence of mind. Readers of *Nature* will be interested to have her account of the incident.

She says (*in lit*, May 6, 1945), "A Berlin entomologic professor, Bisschop, had shown very much interest in our Museum because of the well-known ant collection of Wasmann, which they took or stole and brought it to Berlin. You can read the history in the cutting ('Time' 20 Nov 1944). He threatened me 'Ich werde Sie sofort einsperren', because I refused to tell him where I had hidden the collection, after some discussion with the Nazi mayor they show him the ants. I had some exciting weeks, because I divided the collection and they did not notice it here, but I was afraid that the professor would pay more attention in Berlin—fortunately I never heard anything."

Reports from Belgium and Holland now coming through fortunately suggest that the theft of the Wasmann collection was the act of an individual bully rather than part of a scheme of systematic spoliation.

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SOCIETY FOR GENERAL MICROBIOLOGY

THE proceedings of the inaugural meeting of this Society have been reported in *Nature* of March 17, 1945, p 340, together with a brief summary of the address then given by the Society's first president, Sir Alexander Fleming. It is now possible to add some notes on the contents of the interesting papers read at the inaugural meeting.

In the first place, one point in Sir Alexander Fleming's address not previously mentioned will no doubt interest many research workers. Sir Alexander pointed out that team-work is not always an advantage. If, he said, he had been, in 1928, one of a team studying variation in staphylococci, he would, when a mould contaminated one of his culture plates, have "played for the side" and would have gone with the staphylococci, instead of following up the side track which led, by devious paths, to penicillin. "The lone hand has," he said, "advantages as well as the much-advertised team-work, but each in its own place."

There are many who will agree with this. Team-work can be over-emphasized, and better results, outside the field of 'applied' research at any rate, may come from the looser associations between individuals working in the closely inter-related laboratories of different branches of science in residential universities. These are teams with a difference, and perhaps the difference is often vital to discovery. It could, indeed, be argued that, if we had more residential universities of moderate size, fewer scientific societies would be required and more discovery would result. If teams were needed for organized attacks upon selected problems, these could then be the more easily recruited from groups of men who would work better together because they always had been working together and knew each other's strengths and limitations.

The importance of the constant intercourse of individuals provided by a residential university cannot be over-estimated. It was, in fact, brought out by Dr Marjory Stephenson in her paper on "Levels of Microbiological Investigation." As knowledge increases, she said, and technique becomes more difficult, interdepartmental collaboration is "strongly indicated." Workers must be refreshed by contacts with work at other levels, and she gave a table illustrating the levels to which she referred. None of these, she insisted, is to be regarded as higher or lower than any of the others. At level *A*, represented by the early Pasteur period from 1858 onwards, and by modern work on marine, river and lake populations, on ruminant digestion and the soil, mixed cultures of organisms growing in natural environments are used. At level *B*, represented by the later Pasteur period from 1876 onwards, pure growing cultures of organisms in laboratory media are used. To this level belong the great triumphs of medical bacteriology, which resulted in the isolation in pure culture and identification of causal agents of infectious diseases, specific fermentation and chemical changes in the soil. Most medical and epidemiological bacteriology is still done at this level and almost every modern discovery must begin here, but this technique cannot reveal the mechanism by which the effects of a given organism revealed by it are brought about. At level *C*, dating from 1919 onwards, the substrate is simplified and a beginning is made with the study of the mechanisms by which an organism in pure culture produces its chemical effects. Non-proliferating cells in

pure culture on chemically defined substrates are used. This method gave us the early studies on intermediary processes of fermentation, on the use of poisons, inhibitors and fixatives, and also the early studies on oxidation, reduction, deamination and so on. At level *D*, dating from 1930 onwards, pure growing cultures in highly purified media are used, this level has given us detailed studies of growth requirements, nutritional needs, chemotherapy and microbiological assay. At level *E*, beginning in 1940, cell-free enzymes and co-enzymes in pure substrates are employed. It is a development of level *C*, but the enzymes are separated and it is shown how each produces its effect on its own particular substrate. Greater precision is provided in our knowledge of fermentation processes and correlation with the chemical activity of animal and plant tissues. It is not confined to filterable enzymes. Enzymes can now be extracted from the bacterial cell itself (for example, from *Bact. coli*), and study and work of this latter kind is nowadays gathering momentum and volume.

These levels represent different methods of technical approach. The workers at each level are dependent upon each other, because facts established at levels *A* and *B* provide the starting-point for work at levels *C*, *D* and *E*, and results obtained at levels dealing with enzymes must be referred back to level *B* for epidemiological verification and animal experiment. Incidentally, Dr Stephenson put in a plea, which many will support, for the abolition of the terms 'fundamental' and 'pure' science.

Mr F C Bawden, discussing plant viruses, reminded the Society that viruses were discovered by the breakdown of bacteriological techniques, namely, by the discovery that an apparently sterile filtrate was infectious. The chief techniques of the bacteriologist are therefore not suited to the study of viruses. The protein chemist provides the most useful new techniques. Several viruses have been obtained from nucleoproteins and some are fundamentally different from organisms, chemically they are less complex and their internal structure is much less regular than that of the simplest known organisms. In their purified state they resemble constituent parts of organisms rather than whole organisms, and we may ultimately have to deal with them as such. They are favourable material for the study of mutations and multiplication, and they are attractive subjects for the protein chemist. Plant viruses provide excellent antigens for serological studies, they readily produce antibodies when they are put into animals. The study of viruses brings together workers in widely separated fields.

Prof W B Brierley used the grey mould, *Botrytis cinerea*, to illustrate his discussion of problems presented by the micro-fungi. The morphology of these organisms is no guide to their physiology, for two individuals may look alike and bear the same name (for example, *B. cinerea*) and yet show very wide difference in behaviour. The unit of behaviour is the experimentalists' strain of the organism. Discussing the value of morphological, cultural and physiological criteria for the delimitation and characterization of species, varieties and strains, and the genetic and taxonomic relationships of these categories in the light of variation in the microfungi, Prof Brierley concluded that we urgently need genetic and behavioural study which aims at systematic grouping on a cultural and behavioural basis at the level of the strain.

The importance of the general theme discussed by

reley is underlined by the trend of discovery than one field of biological research. In biology, for example, the existence of what are 'physiological strains' of certain species of which are morphologically indistinguishable have long been known. Epidemiologically these are often very important. Thus it is not to distinguish structurally *Ascaris lumbricoides* the pig from *A. lumbricoides* of man, yet, when infected himself with *A. lumbricoides* from the pig, he suffered only respiratory symptoms due to migration of the larvae to his lungs, and the pig was unable to develop to the adult stage in his lungs. It has been claimed, conversely, that the strain of *A. lumbricoides* will not develop to the adult stage in the pig, although it may do so in the human. That the experimental pig's resistance is due to a diet deficient in vitamin A. Similar physiological strains of the sheep stomach worm, *Haemonchus contortus*, and the gapeworm *Syngamus trachea* in poultry have also been recognized. The subject was further discussed in the paper given at the meeting of the Microbiological Society by Dr. Cecil A. Hoare, who described the morphologically identical but physiologically different strains of certain Protozoa. In many of these strains exist among the blood-sucking Protozoa, their host-relationships are different from several points of view. Some strains differ from each other in their host specificity, others in the different diseases in the same host, others in their degree of virulence to the host. These physiological groups include both races which are stable and hereditarily fixed and strains which are environmentally induced and unstable, the latter being comparable to the so-called 'enduring modifications' (*dauermodifikationen*). Biological races of Protozoa are equivalent to the 'types' recognized among the bacteria. The available data indicate that in both groups the differences between the groups in question are determined by the same factors, namely, variation in antigenic composition. In both Protozoa and Bacteria, therefore, the distinction between biological races resolves itself into differences in the chemical constitution of their antigens. Dr. Frey directed attention to the unsatisfactory nature of the nomenclature used for biological groups in general, and suggested that biological races should be assigned to an independent systematic position, representing a taxonomic unit subordinate in rank to species or subspecies. With this most parasitologists, in any rate, will agree. Some such measure is indeed being forced upon them by the epidemiological and the consequences of modern work on the host-parasite relationships of many kinds of parasites. No doubt the necessity for it will be even clearer and the scientific basis for it will be provided when improvements in the technique of the cultivation of metazoan parasites makes possible work at the levels *D* and *E* suggested by Dr. Stephenson.

Dr. R. H. Hopkins, discussing yeasts, pointed out that the chemist's conception of yeasts as unicellular budding organisms which produce alcoholic fermentation of certain sugars does not coincide with the 'true yeasts' or the 'yeast-like fungi' of the biologists. Earlier classifications of the yeasts are to be replaced by a classification based upon physiological work. The introduction of a synthetic medium to remove discrepancies due to the variable composition of media upon which yeasts are grown. In recent genetic work, Prof. Hopkins suggested that from it we may expect not only a new

and sound system of classification, but also perhaps improved yeasts, for industrial purposes, produced by planned breeding. While the breeding of hybrids is confined to spore-forming yeasts, new yeast types may result from mutations induced by irradiation, toxic chemical agents, such as lithium chloride, cyanides and camphor, and other means, and these methods should be applicable to non-spore-forming yeasts also. Among examples of this kind of work given by Prof. Hopkins was Thaysen's production of *Torulopsis utilis* var. *major* by the use of camphor (*Nature*, 152, 526, 1943).

Dr. A. T. R. Mattick discussed some basic problems of dairy bacteriology. One of these is the resistance of bacteria to heat, which is intimately connected with the sterilization of milk equipment and with pasteurization. Cheese-making provides the problem of the lactic streptococci which are normally added to milk to produce the lactic acid necessary for the optimum coagulation due to rennet, but these streptococci produce, if they are heated above the normal cultivation temperature of 22° C, large quantities of acetic acid, and at lower temperatures other products appear. The practical importance of bacteriophage in cheese-making is considerable, for bacteriophage freely attacks the lactic streptococci used, and strains of streptococci insusceptible to local bacteriophages are needed. Dr. Mattick also described the steps by which he and Mr. A. Hirsch (see also *Nature*, 154, 551, 1944) developed the work of Whitehead in New Zealand on the substance or substances recoverable from milk which inhibit the growth of streptococci used to start the production of acid. Mattick and Hirsch found that this inhibitory substance inhibits also, both *in vitro* and *in vivo*, the growth of some streptococci which are pathogenic to man and also that of certain acid-fast bacteria, including *Mycobacterium tuberculosis*. It is possible that this substance may be useful for the control of bovine mastitis. The work being done at the London School of Tropical Medicine upon what is apparently the same substance has already been noted in *Nature* (155, 584, 1945). In cheese-making, said Dr. Mattick, the moulds are also important, for they are used to ripen some of our choicest cheeses. Thus *Penicillium roqueforti* ripens Stilton cheese, but the strain used makes "a world of difference to the flavour".

Dr. G. H. Wooldridge, discussing the relationship of veterinary science and microbiology, said that veterinary science has gained much from the work of microbiology and has also contributed its share to our knowledge of microbiology. He gave many examples of outstanding work by veterinarians. To them we owe much of our knowledge of anthrax, tuberculosis, glanders, rabies, foot and mouth disease, braxy, rinderpest, the diseases of sheep caused by anaerobic bacteria and other diseases which may profoundly affect human civilization. The discovery made by Griffith Evans in 1850 that surra is due to a trypanosome was the forerunner of the work of Bruce, a medical man, on nagana, a disease of horses due to a trypanosome, and Bruce applied that work to the study of human trypanosomiasis. Co-operation between the medical man Theobald-Smith and the veterinarian Kilburn in the United States discovered that red water fever in cattle is due to a piroplasm transmitted by a tick. Veterinary workers should study more intensively the host-parasite relationship and the control of the spread of disease.

U.S. NATIONAL PATENT PLANNING COMMISSION: SECOND REPORT

IN its first report on the American patent system, the National Patent Planning Commission directed attention to certain aspects of the general operation of the patent laws. The present report* deals with the administration of patents that have come to be owned outright by the Government and also with the respective rights of the Government and its employees and contractors in inventions evolved during the employment or contractual relationship.

On the matter of government-owned patents, the Commission recommends that the Government should "as a general rule continue to pursue the historic policy of not exercising the right to exclude conferred by patents which it owns, of not attempting to exclude its own citizens from engaging in any enterprise, of not seeking to derive revenue from patents, and of not undertaking control by means of patents. Inventions covered by patents owned by the Government should be available for commercial and industrial exploitation by anyone, with, however, the recourse open to the Government to take different action in exceptional cases." In recommending the Government to continue to follow this historic policy and to make inventions covered by Government-owned patents available for exploitation by anyone, the Commission recognizes that there are many patents on inventions developed by, or for, the Government that would be of great public benefit if they were commercially exploited. What prevents such inventions from being commercially exploited, however, is that manufacturers are generally unwilling to make substantial investments in commercializing them if they are also available to competitors. The Commission therefore recommends that suitable legislation should be enacted to confer on the Government the power to grant exclusive licences or to assign Government-owned patents "under appropriate conditions and safeguards whenever it is determined that such action is necessary to assure the commercial development of an invention of a Government-owned patent."

On the policy to be followed regarding the respective rights in employee inventions, the Commission finds that Government policy has not been uniform, but, even so, recommends that it should not be governed by rigid rules prescribed in advance for all departments and all cases. The opinion is expressed that it should be a matter primarily for departmental treatment and in the two extreme cases, first, when an employee is employed to invent and, secondly, when an employee makes an unrelated invention by use of his own time and facilities, the rule of the general law should be followed. In departments confronted with substantial patent problems, general regulations should be maintained or promulgated.

In the report it is stated that a considerable amount of governmentally subsidized research in connexion with the War is being conducted by educational institutions and by private concerns under Government contracts, and that patent rights resulting from such research have been disposed of in various ways. A common feature of these ways is a contractual

clause by which the Government has the obtaining licences on reasonable terms, Commission expresses the opinion that patent clause is unfeasible and undesirable each case should be decided in accordance with facts involved.

In order to correlate the patent policies of the various Government agencies, the Commission recommends that there should be a central control body, in the Executive 'President, having the following principal functions and duties:

(a) Promulgating general policies and approving departmental policies regarding employee inventions, and determining disputes.

(b) Supervising and approving the management of patent rights by the individual departments, including granting exclusive licences for Government-owned patents.

(c) Instructing and advising departmental agencies, collecting information, conducting investigations, and making appropriate recommendations.

In commenting in *Nature* (153, 12, 194) on the First Report of the National Patent Planning Commission, it was pointed out that the numerous technical changes recommended by the Commission were almost uniformly such as to bring the American patent system more closely in line with that of Great Britain, the same principles being applicable to the present report. The British system, acting through the Department of Science and Industrial Research and the Imperial College of Science, Technology and Industry, has power, which the Commission recommends be conferred on the Government of the United Kingdom, to assign or to license patents owned by it. The procedure suggested by the Commission for dealing with employee inventions is in close agreement with the procedure established many years ago in Britain as a result of the report of the Departmental Committee on Patents presented by Sir Kenneth Lee.

WILLIAM S. JARR

THE MENISCUS TELESCOPE

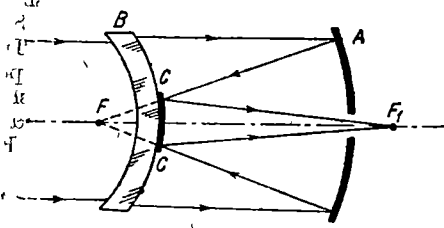
IN the Soviet Union at the present time, a new system of telescope construction is engaging the interest of astronomers and those concerned with the erection of telescopes, whether for research or for instructional purposes in schools. The system, called the meniscus catadioptric system, worked out in 1941 by Dr D. D. Maksutov of the State Optical Institute. The principles involve the advantages to be derived therefrom have been described by Dr Maksutov in an article which appeared recently in the journal *Nauka*, published by the Academy of Sciences of the U.S.S.R.

In its simplest form, the optical system of the meniscus telescope comprises a single thick mirror with spherical surfaces concave to one another, in which is placed some distance in front a silvered or aluminized, spherical mirror. This produces a diverging lens of exceedingly low power, which produces appreciable spherical aberration, but, for example, from a star, focal rays, for example, from a star, focal rays, remain nearly parallel after reflection and are reflected back by the mirror, forming an image between the mirror and the meniscus. Spherical aberration is produced.

* Government-owned Patents and Inventions of Government Employees and Contractors. Second Report of the National Patent Planning Commission. Pp 27 (Washington, D.C., 1944).

Prof. is and the mirror, but one is positive and the other is negative. It is this fact which is the basis of the theory and the design of the meniscus telescope. They have been built. Maksutov has succeeded in that by suitable selection of the radii of curvature of the meniscus and mirror, the thickness of the meniscus and the quality of the glass used, it is possible to arrange that the spherical aberration of the mirror is compensated for by the spherical aberration of the meniscus lens. In addition, the meniscus permits the almost complete removal of coma. By these means, sharpness of image in the field of view is readily attainable. Maksutov has also shown that it is only necessary to take into the calculation the distance between the meniscus and the mirror to establish the conditions for a field of view which will be well defined by an area sufficiently great for all practical purposes.

The principle may be used in various types of complex telescopes. The accompanying figure shows one such type. Here the meniscus and mirror are placed closer together than is usual in the Simeiz type, and the centre portion of the meniscus is so placed that the reflected rays from the concave mirror fall on the meniscus, are reflected by the convex mirror, pass through an opening in the meniscus and form the image.



The meniscus telescope combines most of the good features of both refractors and reflectors and eliminates the unsatisfactory features. It is extremely compact and powerful; it is generally of closed construction, like a refractor, and it is achromatic, like a refractor. Moreover, it is of great significance, from the point of view of simplicity and cheapness of manufacture, that all the optical elements are parts of spherical surfaces.

The superiority of the meniscus type over the other two main types of telescopes used for astronomical purposes may be illustrated by taking as examples, the Yerkes refractor, the Simeiz reflector and the meniscus telescopes now planned for construction in the USSR. These examples are comparable since the aperture in each case is 1 m. The Yerkes refractor has a tube-length of 20 m., and the object-glass consists of two pieces of optical glass (crown and flint), but in spite of its great length, the quality of the image obtained is poor on account of chromatic aberration. The Simeiz reflector (now destroyed) had a parabolic mirror 1 m. diameter and its tube-length was 17 m. The image quality at the centre of the field was faultless, but it deteriorated rapidly towards the edges. The meniscus telescope referred to has a tube-length of a little less than 3 m. It is expected to be sharp over a fairly wide field. Its power will be considerably greater than that of a reflector of similar diameter. It will consist of one lens in optical glass. Crown glass or, indeed, almost any type of glass, could

be used, but crown glass has naturally been chosen since it is more transparent to violet and ultra-violet light.

Because of the reduction in size the cost of building observatory domes, etc., will be much less with meniscus telescopes than with other types. It is estimated that the Simeiz type and the Yerkes type would cost four times and seventy times, respectively, the amount which will be expended on a 1 m. diameter meniscus telescope.

Many observatories, together with their equipment and instruments, have been destroyed during the War, but Soviet astronomers are determined on the speedy restoration of these and the construction of new observatories where instruments, embodying all the refinements of recent research, will rival the best available elsewhere. They are planning, also, an increase in the number and size of university observatories, and they are proposing to establish smaller telescopes in both town and country schools. The meniscus type of telescope offers the best means of achieving these aims with the minimum of delay and the minimum of expense.

G. STANLEY SMITH

¹ Maksutov, D. D., *Nauka i Zhizn (Science and Life)*, No. 9, p. 1 (1944). The theory is described in detail and dimensional particulars are given under the reference Maksutov, D. D., *J. Opt. Soc. Amer.*, 34, 270 (1944).

RECENT WORK ON RHENIUM

IN the two decades since rhenium (Mendeléeff's dwi-manganese) was discovered, hundreds of its compounds have been reported. Among the latest are some stable complexes in which the element is present as the cation. Lebedinsky and Ivanov-Emm (*J. Gen. Chem., U.S.S.R.*, 13, 253, 1943) have described the complexes derived from saturated solutions of the double chlorides, K_2ReCl_6 and K_2ReCl_5 , by using a large excess of ethylene diamine. This is apparently the only suitable base, since ammonia and pyridine do not react in the same way. During the reaction, rhenium oxidizes to the pentavalent state and $ReO_2(C_2H_4N_2H_4)_2Cl$ separates. It gives no precipitates in aqueous solution except with cobaltinitrites and platinum chlorides.

A corresponding iodide, only slightly soluble in water, was obtained by metathesis with potassium iodide. When treated with hydrochloric acid the substances yield $ReO(OH)(C_2H_4N_2H_4)_2Cl_2$, which is isolated from its saturated solutions by precipitation with alcohol. A curious compound, $ReO(OH)(C_2H_4N_2H_4)_2PtCl_6$, results when the chloride is mixed with sodium platinum chloride solution. A corresponding iodide is also known. Both are only slightly soluble in water, but the solutions contain rhenium ions.

When rhenium salts were first obtained there was some controversy over the efficacy of hydrogen sulphide as a reagent for precipitating rhenium as sulphide. Geilmann and Lange (*Z. anal. Chem.*, 126, 321, 1944) now state that the heptasulphide is completely precipitated from slightly acid solutions by hydrogen sulphide under pressure, especially if the mixture is heated for half an hour before filtering. For estimating rhenium the washed precipitate is converted into sodium per-rhenate with sodium hydroxide and perhydrol and then re-precipitated as nitron per-rhenate. Rhenium compounds fused with sodium carbonate and sulphur yield an insoluble alkali complex.

Another selective reagent, toluene-3,4-dithiol, is found to give a green complex with rhenium (and also with molybdenum) and a blue one with tungsten (Miller, *Analyst*, 69, 112, 1944). The *K*-absorption limit for rhenium is reported to be 172.66 by Manescu (*C.R. Acad. Sci.*, 216, 732, 1943) who examined its salts between 'Cellophane' sheets using a potential of 100–125 kV.

According to Naray-Szabo, rhenium trioxide crystals are cubic (*Naturw.*, 31, 466, 1943).

FORTHCOMING EVENTS

Saturday, June 30

ASSOCIATION FOR SCIENTIFIC PHOTOGRAPHY (at the Alliance Hall, Westminster, London, S.W.1), at 2.30 p.m.—Mr H. White "Make the Photograph tell a Story."

Friday, July 6

PHYSICAL SOCIETY (at the Royal Institution, Albemarle Street, London, W.1), at 5 p.m.—Prof. Arturo Duperier "The Geophysical Aspect of Cosmic Rays" (29th Guthrie Lecture) (Fellows of the Royal Astronomical Society and members of the Royal Meteorological Society are also invited to attend).

Saturday, July 7

SOUTH-EASTERN UNION OF SCIENTIFIC SOCIETIES (at the Rothamsted Experimental Station, Harpenden), at 9.30 a.m.—Fiftieth Annual Congress Prof. W. G. Ogg "Some Aspects of the Work at Rothamsted."

INSTITUTE OF PHYSICS (LONDON AND HOME COUNTIES' BRANCH) (in the Physics Department, Imperial College of Science and Technology, South Kensington, London, S.W.7), at 2 p.m.—Discussion on "The Corrosion of Metals."

APPOINTMENTS VACANT

APPLICATIONS are invited for the following appointments on or before the dates mentioned.

CIVIL ENGINEER by the British Overseas Airways Corporation, for control and supervision of civil engineering and building work in the India and Burma Region—The Ministry of Labour and National Service, Central (T and S) Register, Room 5/17, Sardina Street, Kingsway, London, W.C.2, quoting E 1659 XA (July 6).

LECTURER (full-time) IN ELECTRICAL ENGINEERING—The Principal, Handsworth Technical College, Golds Hill Road, Birmingham, 21 (July 7).

LECTURER-IN-CHARGE OF THE CHEMISTRY DEPARTMENT EVENING CLASSES in the East Ham Technical College, to be responsible for organization and development of part-time courses up to Higher National Certificate standard and courses in both Pure and Applied Chemistry—The Chief Education Officer, Education Office, Town Hall Annex, Barking Road, East Ham, London, E.6 (July 7).

ASSISTANT LECTURERS IN BOTANY, GEOGRAPHY (climatology and cartography), and ZOOLOGY—The Registrar, University College, Exeter (July 9).

BOROUGH ELECTRICAL ENGINEER AND MANAGER—The Town Clerk, Town Hall, Leigh, Lancashire (endorsed 'Borough Electrical Engineer and Manager') (July 10).

WATER ENGINEER AND MANAGER—The Town Clerk, Council Offices, North Street, Chichester, Sussex (endorsed 'Appointment of Water Engineer') (July 11).

DIRECTOR OF WORKS by a Governmental Office (candidates must be Corporate Members of the Institution of Civil Engineers and must have had experience in carrying out constructional work abroad)—The Ministry of Labour and National Service, Appointments Department, A.9, Room 5/17, Sardina Street, Kingsway, London, W.C.2, quoting E 1700 A (July 13).

ASSISTANT ADVISER IN PLANT PATHOLOGY—Prof. R. G. White, School of Agriculture, University College of North Wales, Bangor (July 14).

DEMONSTRATOR IN THE PHYSICS DEPARTMENT, for general teaching duties—The Dean, Guy's Hospital Medical School, London Bridge, London, S.E.1 (July 14).

LECTURER IN PHYSICS—The Principal, Royal Holloway College, Englefield Green, Surrey (July 14).

GARDENING INSTRUCTRESS for a County Technical School for Girls with a demonstration garden at Chislehurst—The County Education Officer, Springfield, Maidstone (July 14).

ASSISTANT LECTURER IN CHEMISTRY, and an ASSISTANT LECTURER IN CLOTH MANUFACTURE, at the Bradford Technical College—The Director of Education, Town Hall, Bradford (July 14).

ASSISTANT LIBRARIAN in the University Library, and a SUB-LIBRARIAN in the Faculty of Engineering—The Registrar, The University, Liverpool (July 15).

PROFESSOR OF CHEMICAL TECHNOLOGY at the University of Madras—The Registrar, University of Madras, Chepanik, Triplicane, Madras (by Air, July 15, copy to the High Commissioner for India, General Department, India House, Aldwych, London, W.C.2).

LIBRARIAN—The Secretary, The University, 38 North Bailey Durham (July 16).

ASSISTANT LECTURER IN HORTICULTURE with special qualifications in Horticultural Machinery—The Registrar, The University, Reading (July 16).

RESEARCH OFFICER FOR SPECTROSCOPIC INVESTIGATIONS, Division of Industrial Chemistry, Council for Scientific and Industrial Research Melbourne—The Secretary, Australian Scientific Research Liaison Office, Australia House, Strand, London, W.C.2 (July 16).

LECTURER IN GEOGRAPHY (with special qualifications in Cartography)—The Registrar, The University, Reading (July 16).

LECTURER (or ASSISTANT LECTURER, according to qualifications) IN THE DEPARTMENT OF BOTANY—The Secretary, King's College Strand, London, W.C.2 (July 20).

SECOND ASSISTANT PETROLEUM TECHNOLOGIST in Trinidad—The Ministry of Labour and National Service, Appointments Department, A.9, Room 5/17, Sardina Street, Kingsway, London, W.C.2, quoting F 4411 A (July 21).

SCIENTIFIC ASSISTANT—The Deputy Director, Imperial Bureau of Dairy Science, Shinfield, Reading, Berks (July 21).

UNIVERSITY LECTURER IN GEOLOGY—The Secretary of the Appointments Committee of the Faculty of Geography and Geology, Department of Mineralogy and Petrology, Cambridge (July 30).

SECRETARY TO THE UNIVERSITY COUNCIL—The Secretary, University Registry, Cathays Park, Cardiff (July 31).

LECTURES IN CHEMISTRY—The Registrar, Trinity College, Dublin (August 20).

WARDEN OF CREWE HALL (the University Hall of residence for Men) who must be a graduate and will be required to give some part in University teaching—The Registrar, The University, Sheffield (August 31).

CHAIR OF MEDICINE in the University—The Registrar, The University, Sheffield (October 31).

CHAIR OF SURGERY tenable at the British Postgraduate School—The Academic Registrar, University of London College, Richmond, Surrey (January 1).

LECTURER IN CHEMISTRY, with qualifications in Organic Chemistry—The Registrar, University College, Exeter.

LABORATORY ASSISTANT (man or woman) FOR THE BIOMEDICAL RESEARCH LABORATORY—The Warden and Secretary, London (Royal School of Medicine for Women, 8 Hunter Street, London, W.C.1).

LABORATORY APPRENTICES (boys or girls) IN THE DEPARTMENT OF BOTANY, PHYSICS, PHYSIOLOGY AND ZOOLOGY—Bedford College for Women, Regent's Park, London, N.W.1.

RESEARCH MANAGER, a CHIEF CHEMIST, CHEMISTS (2 or 3) with some years research experience, and CHEMISTS and PHYSICISTS—The Director, Paint Research Institute, Teddington, Middlesex.

TEACHER IN ENGINEERING SUBJECTS up to Higher National Certificate standard in day, part-time, and evening classes—Erith Technical College, Belvedere, Kent.

TEACHER (well qualified) OF SCIENCE—The Principal, Institute, Tunbridge Wells.

LECTURER (full-time) IN THE PHYSICS DEPARTMENT—The Principal, Northampton Polytechnic, St John Street, London, E.C.4.

HEAD OF THE ENGINEERING DEPARTMENT—The Registrar, College, Portsmouth.

TEACHER (full-time, day and evening) OF ENGINEERING in the Harrogate Technical Institute—W.E.C. Jalla, Offices, Harrogate.

TEACHER OF ENGINEERING SUBJECTS, including Worked Examples and Drawing, and a TEACHER OF ELECTRICAL ENGINEERING in Day and Evening Classes, in the Mexborough School of Engineering—B.B. Stockdale, Education Office, Mexborough, Y.

ASSISTANT LECTURER IN AGRICULTURE, and an ASSISTANT LECTURER IN AGRICULTURAL BOTANY—The Registrar, University College, Wales, Aberystwyth.

LECTURERS (full-time) IN GENERAL ENGINEERING SUBJ. Higher National Certificate standard, ELECTRICAL SUBJ. University Degree standard, and PHILOSOPHY (candidates possess a good Degree in Philosophy or Psychology and be able to take a class in Elementary Logic)—The Clerk to the Governors, St. West Essex Technical College and School of Art, Forest Road, Walthamstow, London, E.17.

TEACHER (well qualified) OF MECHANICAL ENGINEERING in the Harrogate Technical Institute—W.E.C. Jalla, Offices, Harrogate.

TEACHER (well qualified) OF ELECTRICAL ENGINEERING in the Harrogate Technical Institute, Darnley Road, Gravesend.

REPORTS and other PUBLICATIONS

(not included in the monthly Books Supplement)

Great Britain and Ireland

Association for Planning and Regional Reconstruction. No. 5 (A.5) Resources of the Sea. Pp. 41 (London: Association for Planning and Regional Reconstruction, 1945).

Imperial Bureau of Pastures and Forage Crops. Bulletin. Ley Farming in Sweden, a Field Day at Svalof. Pp. 44 (Aberystwyth: Imperial Agricultural Bureau, 1945).

Proceedings of the Science (Research) Society. No. 3. The Biological Panel. Pp. 22 (Richmond: Science Society, 1945).

National Institute for Research in Dairying. Report Years 1941, 1942 and 1943. Pp. x+68 (Shinfield: National Institute for Research in Dairying, 1945).

U.S. Office of War Information. Symposium on P. in Medicine. Pp. vi+260. Symposium on Recent Advances in Medicine. Pp. vi+229. (Reprints from the Medical Clinics, 1944.) (London: U.S. Office of War Information, 1944).

Catalogue

Brochure of Mass Miniature Radiography. Pp. Watson and Sons (Electro-Medical), Ltd., 1945.